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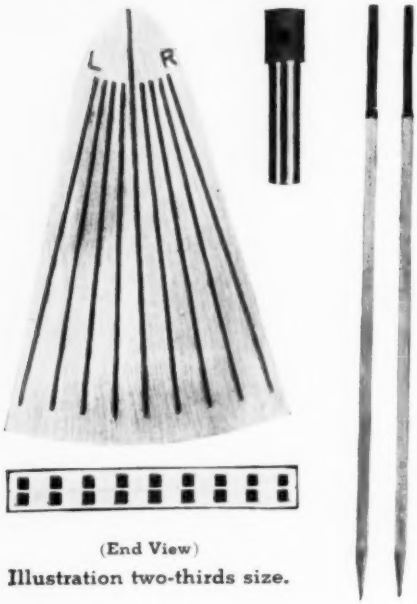

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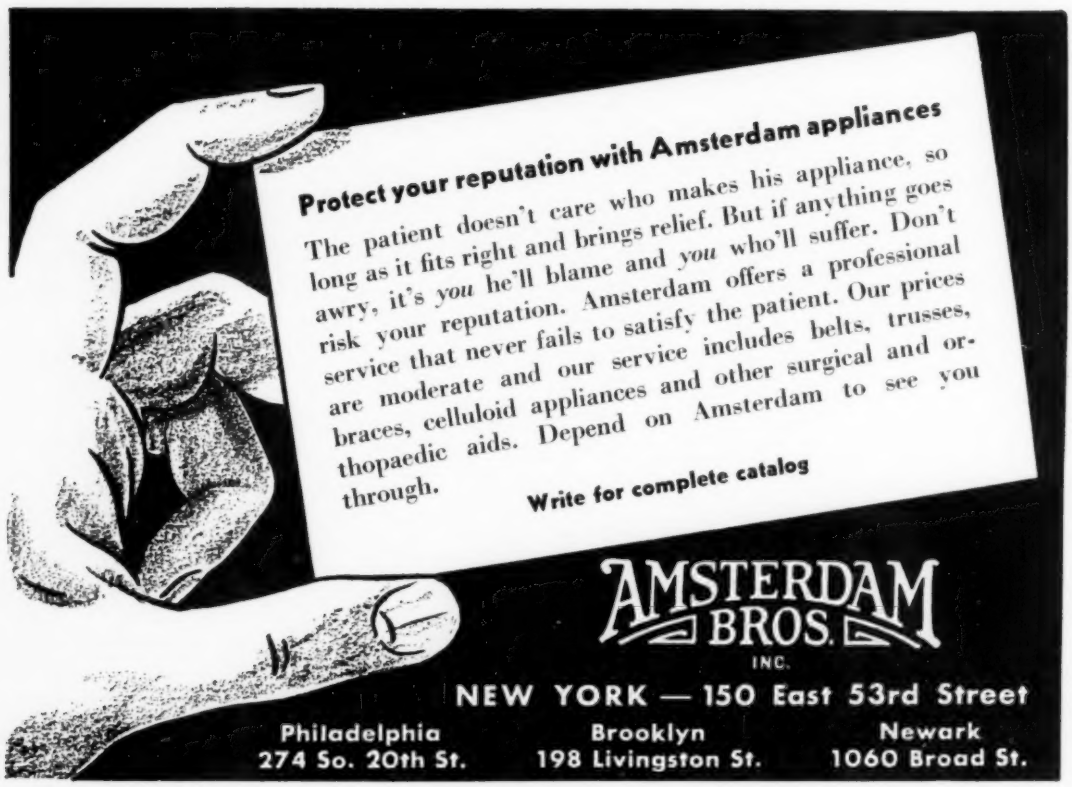
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The Journal of Bone and Joint Surgery

THE PRESIDENT'S ADDRESS

A Plea for the Fundamental Principles of Orthopaedic Surgery *

BY A. BRUCE GILL, M.D., PHILADELPHIA, PENNSYLVANIA

Fellows of the American Academy of Orthopaedic Surgeons: It is a great honor to stand here to address you as your President. This Academy has justified the foresight and the wisdom of its founders and today constitutes the largest body and one of the most important organized groups of orthopaedic surgeons in the world.

I feel your power and enthusiasm and ambition. I can gain a glimpse of the tremendous possibilities of your future. You have made me your leader for the moment. How should I attempt to counsel you; whither should I try to guide you?

Should I attempt to instruct you in knowledge? You could teach your President many things. Should I point out to you new fields of endeavor? Your own genius is constantly driving you into these unexplored realms. Should I stimulate you to greater accomplishment? You are even now bursting with energy and ambition. How then shall I address you? Is there anything of myself that I can give to you, whether you accept it or not?

As an older man than many of you who are sitting before me, as one trained in the old and more conservative methods of orthopaedic surgery and yet familiar with the new, as one with a little longer experience and possibly a certain judgment gained thereby, I may serve for you as a bridge between the past and the present, as can also my contemporaries here. What is has grown from what was. Not all of our older methods and experiences were useless; not all of our present ones have yet been tested and proved by time.

We should not forget that the orthopaedic surgeon made a useful place for himself and his art, often in face of opposition by the general surgeon. He observed the laws of growth and repair; he studied physical

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 18, 1938.

and mechanical principles in their application to the human body; he learned the value of rest and the means to secure it in the presence of inflammation. Above all, he stressed the function of the body, its preservation and its restoration, as the ultimate end of all treatment. He never for a moment lost sight of this. Treatment of a case might continue through months and years, but at the very beginning he had a clear mental picture of the final result to be accomplished. Surgical operations were employed, but they were often only an interlude between the preoperative and the postoperative phases of the treatment. He was skilled in manipulation with his hands and used the knife as a last resort. He was thoroughly conversant with the value of physical therapy and the indications for its use.

Surgery, as derived from two Greek words, means to work with the hands. In a broad sense a surgeon is one who practises the healing art with his hands,—whether it be by massage, by manipulation, or by the use of instruments and appliances. However, since the advent of asepsis, the skillful use of the knife has become, properly or improperly, the distinguishing talent and criterion of the great surgeon; and there has been a growing tendency to neglect, to delegate to persons who are not members of the medical profession, and even to discard entirely all the arts of surgery but the use of instruments and mechanical apparatus.

Directly and indirectly because of these self-limitations of the modern surgeon, there have arisen various schools of therapy and thousands of practitioners whom we choose to call irregular because they are outside the ranks and beyond the control of the organized medical profession. Strange to relate, many of them—such as the bone-setter, the chiropractor, and the osteopath—claim to heal by the use of their hands; and to our surprise and astonishment, to our embarrassment and chagrin, they succeed at times where we fail.

In this mechanical age there has been a tremendous production of all kinds of laboratory devices and of machines, instruments, and apparatus for the diagnosis and the treatment of medical and surgical conditions. Consequently, there has been a marked tendency among medical students and practitioners to rely upon these aids rather than upon their own natural powers of observation and the skillful use of their hands. Do we not like too well to shift the responsibility of diagnosis upon the laboratory technician and the roentgenologist? And do we not accept too readily the assurances of salesmen that their costly electrical machines will heal all kinds of disease and that their complicated apparatus will cure all fractures? Let us not forget that our hands are the finest and most cunning instruments ever made. Do we persistently cultivate their skill in diagnosis and treatment?

There is some resemblance today between the changing conditions in Medicine and Surgery and those in Society and the Body Politic.

The course of the arts and sciences has always been related in a general way to social and political order. During periods of upheaval,

of oppression, and of tyranny they have languished, but when a great crisis has been successfully passed and peace, quiet, and order prevail they have flourished. The Greek genius, unsurpassed in the history of the world, that sprang up as naturally and as universally as flowers in the fields, reached its greatest heights after the Persian Wars. The Golden Age of Augustus followed the civil wars of Rome and the consolidation of the empire. The Elizabethan Era came after the Spanish menace had been beaten back and England had entered upon her long and glorious history of freedom and wealth. The American War of Independence and the French Revolution brought to the citizen relief from oppression by the State and the Church and opened the gates to Science which since then has made unbelievable advance.

Then came the Great War which again stirred the world to its depths, and we are now at the beginning of another period of change and readjustment. There is a striving for some new and different freedom, a freedom from poverty and want and worry and anxiety both present and to come, a relief from oppression by class and by wealth and power of individuals and groups of men and corporations. And there is much confusion of thought, of purpose, and of methods. There seems to be too great an inclination to discard the old and to try the new, no matter what or how unproved by time and experience. The lessons of history may be forgotten, the fundamental principles of human nature, which are the basis of individual conduct, of social relations, and of law and order, may be overlooked.

Some peoples have lost faith and confidence in their own powers to reach the ideal and have surrendered their individual rights and liberties to a dictator who promises them national and individual security. To attain a new end they have forgotten and have lost that for which our forefathers fought, the inalienable rights of the individual which no state or form of social organization can take away by force or accept by surrender of the majority. As long as one man lives in whom breathes the spirit of liberty and of justice, the freedom of the human soul cannot be destroyed. Disaster to medicine, art, music, letters, science, and religion has followed swiftly upon the loss of individual freedom.

We must not forget in this present period of confusion and rapid change that there are fixed, established, and undying principles of right and of liberty proved by centuries of happy experience, and we must not sacrifice these in the hope of gaining some new end, good though this end may be in itself. It will prove but a false dream that lures us to destruction. There are no "New Deals" and "New Eras" unrelated to the past and essentially different from them. There are no new principles of right and wrong, of freedom and oppression. The virtues and the vices of men persist, and it is difficult to see that there is less selfishness, less grasping for power, less enmity, and less strife to possess that which belongs to another than in times gone by.

It cannot be denied that there is this deep unrest in the world today,

this striving upward for something which may vastly benefit civilization, ill-defined and chaotic as this urge may be. As men of intelligence and as physicians we cannot ignore it and cling pertinaciously to the past or drift idly with the current. We must aid in finding solutions to these new problems, which, however, may not be attained in our generation, without selfishness, injustice, strife, violence, and tyranny either by the minority or by the majority, and without loss of individual liberty and the right of property upon which our whole civilization rests.

However, apart from these general but vital considerations, I think I can see in our own particular profession some evidence of this same spirit of unrest. There is some tendency to discard the older and conservative methods in surgery, many of which required time and patience and exact attention to details, and to adopt almost overnight, as it were, newer methods which promise much but which have not yet stood the test of time. The former require intimate knowledge of anatomy and physiology and the mechanics of the body. The latter may require only skillful operative technique. New operations or modifications of old ones have appeared by the score,—some to be found useful and to become classic, many soon to be discarded and forgotten.

There appears to be a tendency to neglect the study of the fundamentals of surgery and to place our sole reliance upon methods and fads and gadgets. Consider how many appliances there are for the reduction and immobilization of fractures. It has become the vogue, I might almost say the fad, at the present time to employ them almost entirely and to the exclusion of the older methods of reduction and fixation. Most of them are unnecessary to the surgeon who is familiar with the simple laws of mechanics, who is versed in the principles of fractures, and who has acquired skillful use of his hands in manipulation and in the application of fixation dressings. To treat all fractures by a certain rule and by some special apparatus, as if the rule supplanted the use of the brain and the apparatus that of the hands, is both ridiculous and futile. I wage no war against gadgets in themselves. They often delight one with their neatness, their mechanical nicety, and their efficiency in saving of time and energy. However, I do object to their indiscriminate use without a thorough understanding by the surgeon of the problem which confronts him, of the precise way in which the mechanical apparatus works, of what it may be expected to accomplish, and of any possible dangers or complications attendant upon its use. Moreover, the surgeon should be certain that its use will give him better results than he was able to obtain with the old and familiar methods. The body is a complicated machine and it requires a skilled mechanic to repair it. The surgeon uses his hands and employs tools with which he is familiar and which he knows will accomplish his definite purpose. If he has no efficient tools he may even invent a new one.

Let us, however, beware of adopting new methods too hastily. We recall how a few years ago Sir Arbuthnot Lane taught the open reduction

and plating of all fresh fractures. His dicta in time were accepted by many surgeons in all countries. In the practice of his method not all of these surgeons were as meticulous and skillful as Lane himself, and many cases of osteomyelitis, non-union, and malunion occurred. Then we learned again what we knew before,—that most fractures can be efficiently treated by closed reduction and skillful fixation. A method used successfully by one surgeon may be unsuccessful in the hands of another by reason of some ineptitude and lack of full understanding of the principles involved.

As another illustration, consider the history of the treatment of bone and joint tuberculosis. If we accept as true the conception that tuberculosis is a general disease with a pronounced local manifestation, but with the presence of the tubercle in other places and structures of the body, and that its development is due to a weakening of the resistive processes of the body, then the various methods of the treatment of the local manifestations of the disease in bones and joints will fall into their true perspective. Chronic disease is to be stayed or cured by forces resident in the body itself. Local rest by fixation is but one means of aiding nature to cure the local focus. Whether or not we use prolonged recumbency with traction, or plaster casts, or splints (how few of us have the patience and skill of a Hugh Owen Thomas!) or whether we resort to surgical operation may depend on our own experience and skill. We must, however, recognize that none nor all of these methods of fixation of the diseased joint in themselves and by themselves promise infallible cure. Nature's own forces must be rallied to turn the battle against the invading disease. I decry the indiscriminate employment of biopsy and of surgical operation in the diagnosis and treatment of bone and joint tuberculosis. Present teachings must be viewed in the light of past experience and judged with full knowledge of the principles which underlie the treatment of chronic disease.

Are too many operations performed in the practice of Orthopaedic Surgery? Is there too great a tendency to discard the old and to take up the new or to proclaim as new that which was tried years ago? In recent years operative procedures have been multiplied in our branch of Surgery more rapidly than in any other division of Surgery. Many of our young men believe that they can attain distinction only by the invention of a new operation.

Successful invention can come only after thorough familiarity with the old, its uses and its defects and weaknesses. It seems evident to many of us that surgical procedures are often employed by surgeons who are not thoroughly familiar with the methods of conservative treatment and who are unacquainted with their possibilities. Fusions of the lumbar spine and of the sacro-iliac joints are performed to cure chronic backache when the cause and the origin of the pain are not clearly determined. The result is that many of these operations have not relieved the pain for which they were performed. No operation should be done except for definite

and logical reasons, unless it should be an experimental procedure done as a last resort.

Some operations are performed which do not offer sufficient restoration of function to justify the operative risk. A moderate shortening of an extremity as the result of infantile paralysis may not in itself constitute a severe handicap to the patient. The amount of functional improvement to be secured by leg-lengthening may not balance the surgical risks attendant upon it. It is a primary principle of surgery that no operation should be undertaken routinely, but only after careful consideration of all the factors—physical, mental, social, and economic—that enter into the problem. We must not forget that our specialty was founded in the spirit of conservatism.

You are like a youthful army surging forward. I would counsel you to avoid misapplication and waste of energy, to exercise restraint at times, to curb rashness with sound judgment, to strike a fair mean between conservatism and radicalism, to see the truth written on both sides of the shield, to refrain from fads and fancies, to seek the eternal truth beneath the changing surface, to distinguish fountains of living water from the mirage. Study principles rather than methods. A mind that grasps principles will devise its own methods. Read history and reflect upon the experiences of the past that you may perceive those things that have proved their worth through the years and the centuries and be enabled to avoid the pitfalls of the present and the future.

OPPOSITION OF THE THUMB *

BY STERLING BUNNELL, M.D., SAN FRANCISCO, CALIFORNIA

A great asset to man is the opposable thumb. The hand so useful to all and the livelihood of the manual worker owes much of its efficiency to this pincer action of the thumb.

Opposable digits are not new in nature. Most birds have them. The digits of the African chameleon directly oppose each other around a branch and as far back as the crustaceans there are opposing claws of crabs and lobsters.

In mammals the opposable thumb is found only in the primates and starts with the lowest forms of them, the lemurs. The more arboreal is the monkey, like the gibbon, and the more developed its prehensile tail, as in the western hemisphere, the smaller and less opposable is its thumb, so the spider monkey is even thumbless. A hand without opposition of the thumb has been called "ape hand", but this is an injustice to the apes as in their hands opposition is well developed and it is even more so in their great toes. In man locomotion has been confined to the feet, leaving the hands free to develop handiwork. The pollex has thus become more opposable and the hallux has lost its power of opposition.

DEFINITION AND DESCRIPTION

The term "opposition" is from the Latin "*oppositio*" meaning opposite. It implies opposite and far apart like the opposite points in a circle. In astronomy when two heavenly bodies are 180 degrees apart they are said to be in opposition.

The thumb to be in true opposition must not only be opposite the fingers and far forward from them, but it must also be by rotation diametrically opposite to them,—that is, with the pulp of the thumb facing that of the fingers and with the thumb nail parallel to the palm or volar surface of the fingers. Also, in the motion of flexion and extension, the thumb and the opposing digits should move in exactly opposite directions to each other.

Merely placing the thumb into apposition—that is, in contact with the fingers—or drawing it into the palm is not opposition, nor is it when the thumb fails to rotate and its nail is still at a right angle to the palm.

RANGE OF MOTION OF THE THUMB

Normally the thumb can touch the palm in its distal and radial margins, as well as all of the fingers over most of their surfaces, although this is increasingly less possible on their dorsal and ulnar aspects as the thumb reaches from the index to the little finger. The thumb can also

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 20, 1938.

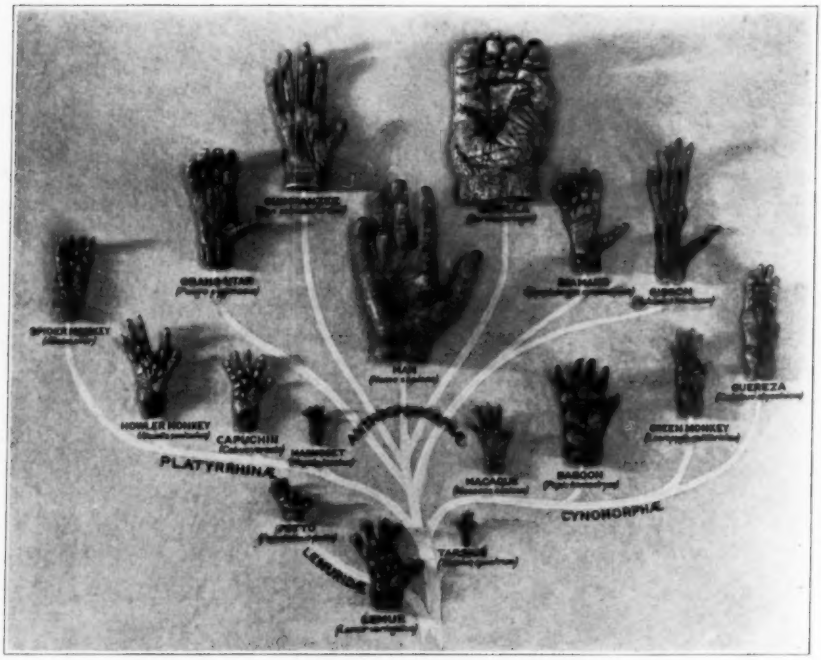

FIG. 1-A

Hands of man and monkeys. Those with the most opposable thumbs are, in order: man, gorilla, baboon, chimpanzee, and orangutan. The more ground dwelling is the monkey, the better developed is the opposable thumb; the more arboreal, the less thumb it has. The more prehensile is the tail, as in new-world monkeys, the less use the animal has for a thumb, until the spider monkey has none at all. (*Courtesy of the American Museum of Natural History, New York, N. Y.*)

pass backward over the radial border of the palm to reach the plane of the dorsum of the hand. From here it can abduct from the hand to about a right angle and then sweep forward from the hand in a semicircle until it touches the base of the little finger. Let us observe the thumb in its excursion through this forward arc. At the start, the thumb and thenar eminence form a cone protruding laterally from the hand. When midway in the path of the semicircle, this cone projects forward from the hand, and the thenar crease is folded to a right angle. If we watch the thumb again through this arc, we will see that at the start the nail is at a right angle to the palm, and the thumb bones are in a straight line as seen from behind. In traversing the semicircle these relations are maintained and a certain strain is felt in the thenar eminence until, as the first third is completed, the strain leaves, the nail starts to rotate in pronation, and the proximal phalanx angulates radially on the metacarpal. As the change occurs, the muscles in the radial half of the thenar eminence conspicuously spring into action and continue the motion. The strain occurs when the adductors are fully stretched by the long extensors of the thumb. The adductors insert on the ulnar side of the proximal phalanx and, when under tension, tend to supinate, but are opposed by the muscles attached to

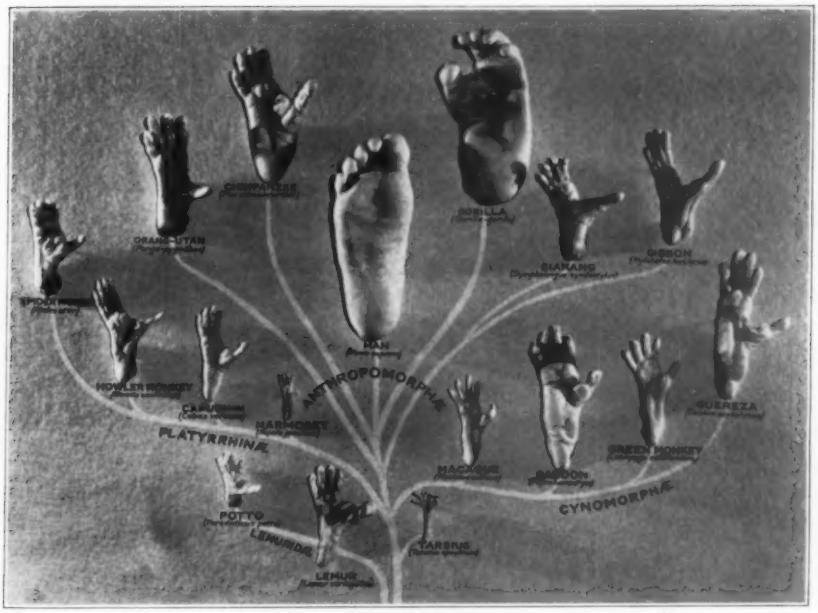

FIG. 1-B

Feet of man and monkeys. In man the feet are used entirely for locomotion, so that the hallux has entirely lost the power of opposition and the pollex has developed it. All monkeys have an opposable hallux far better developed, with the exception of the gorilla and the baboon, than is the pollex. (*Courtesy of the American Museum of Natural History, New York, N. Y.*)

the radial side of the phalanx, principally the outer head of the short flexor. The latter pronates and, after pronation is started, also angulates the phalanx radially. The strain is relieved just as the adductors are relaxed and the short flexors have their way. Throughout the arc the long extensors maintain the necessary stabilization in extension of the three joints of the thumb.

The motion of opposition takes place in the intercarpal, carpometacarpal, and metacarpophalangeal joints. This motion is of two types —angulatory and rotary—and all three joints contribute to each. The carpometacarpal joint furnishes most of the angulatory motion and the metacarpophalangeal joint most of the pronatory motion. The sum of the angulatory movement in opposition is shown in the distal segment of the thumb which angulates through an arc of about 120 degrees, and the sum of the pronatory movement is shown in the plane of the thumb nail which rotates 90 degrees from a position at a right angle to the palm to one parallel with it. In Figures 2-A through 3-B toothpicks are attached to the skin to show better the movements in each segment of the thumb.

The intercarpal movement increases the carpal arch and takes place by the movement of the greater multangular on the navicular and the lesser multangular and by the movement of the latter two in turn on the capitate. This is readily demonstrated by the inability to oppose the

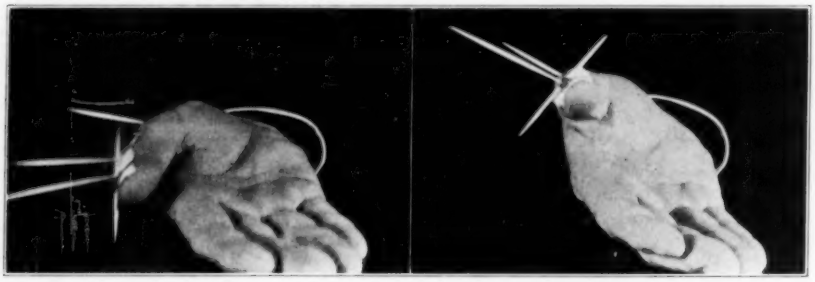

FIG. 2-A FIG. 2-B

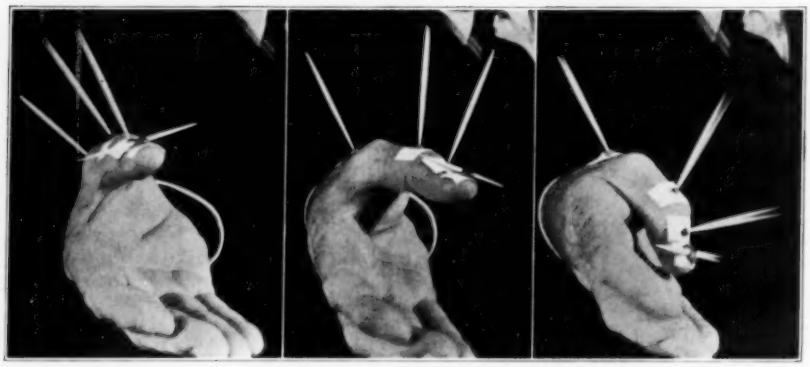

FIG. 2-C FIG. 2-D FIG. 2-E

The successive positions assumed by the thumb in transcribing its normal forward arc of opposition. The toothpicks—one placed crosswise and parallel with the nail and three each vertical to a separate segment of the thumb—are to show more graphicly the angulatory and pronatory thumb movements.

Fig. 2-A: The thumb starts at the side of the hand. The nail is at a right angle with the palm, and the vertical toothpicks are in line with each other.

Fig. 2-B: After the first third of the arc has been traversed, the thumb commences to pronate.

Fig. 2-C: The greatest pronation is between Figs. 2-B and 2-C.

Fig. 2-D: Position of full opposition with the thumb well forward from and opposite the base of the long finger, angulated toward the ulna, and with the nail parallel with the palm. Note the degree of pronation shown in the relative positions of all four toothpicks.

Fig. 2-E: The thumb, now past the position of opposition, is completing its arc and approaching the base of the little finger.

thumb when the carpal arch is prevented from arching. The arching is produced largely by contraction of the thenar muscles which are attached to the transverse carpal ligament. The palmaris longus aids in this. The metacarpal is angulated and pronated on a saddle joint largely by the opponens pollicis aided somewhat by the abductor pollicis longus and the outer head of the flexor pollicis brevis. The proximal phalanx is angulated and pronated mostly by the outer head of the flexor pollicis brevis acting on a ball-and-socket joint.

The main antagonist to opposition is the extensor pollicis longus although this muscle also aids in the motion by its effect along with the extensor pollicis brevis and the abductor pollicis longus in stabilizing the joints of the thumb in extension.

With the wrist dorsiflexed and the thumb in opposition, the cleft open for grasp between the thumb and the palm is then in direct line with the forearm as it should be. Opposition aids in forming a circle with the thumb and index finger and an ellipse with the thumb and little finger.

The degree of opposition may be expressed by the distance which the pulp of the thumb reaches in front of the base of the long finger and also by the pronatory angle or the plane the nail makes with the palm as compared in each instance to these measurements in the normal hand. Thus, opposition in a hand may be expressed as one inch and 45 degrees of angle, compared with three inches and an angle of zero, which are the similar measurements taken for comparison in the other or normal hand.

CAUSES OF LOSS OF OPPOSITION

Loss of opposition results from loss of nerve function to the muscles of the radial half of the thenar eminence, or loss of these muscles themselves, or it may be due to cicatricial contracture from infection which approximates the first two metacarpals, to adhesions which hold back the tendon of the extensor pollicis longus, or to flat-hand from faulty splinting or from ankylosis of the intercarpal and carpometacarpal joints.

METHODS OF RESTORING OPPOSITION

Opposition may often be restored, depending on its cause, by nerve suture, by excision of the cicatrix binding the first and second metacarpals or of adhesions of the extensor pollicis longus tendon, or by wedge osteotomy in case of ankylosis of the carpus. In eleven cases the author has sutured the motor thenar branch of the median nerve to restore opposition. The motion returned in about thirteen months. In the writer's series of eighty-three repairs of the median nerve by suture, opposition has been restored in 66 per cent.

When the nerve or thenar muscles are irreparable and the mobilizing operations mentioned have been done if necessary, then tenoplasty by

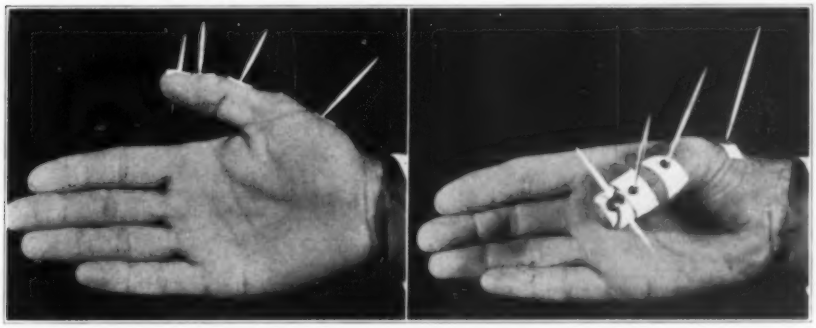

FIG. 3-A FIG. 3-B

Views from the front with the thumb at the side of the hand and in full opposition. Note the degree of pronation of the segments of the thumb made graphic by toothpicks. The nail rotates through 90 degrees. The greatest pronation occurs at the metacarpophalangeal joint.

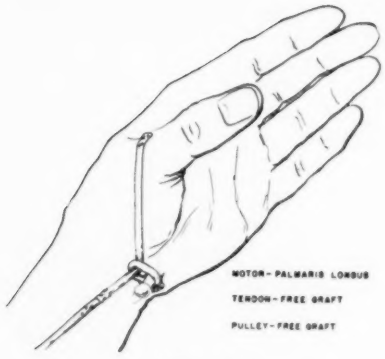

FIG. 4-A

FIG. 4-B

FIG. 4-C

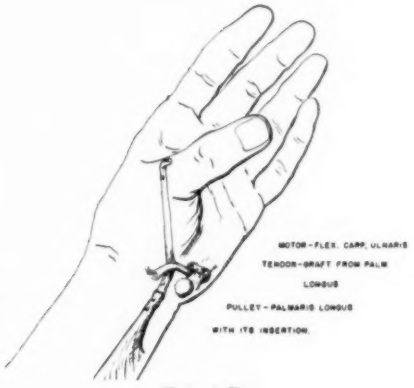

FIG. 4-D

FIG. 4-E

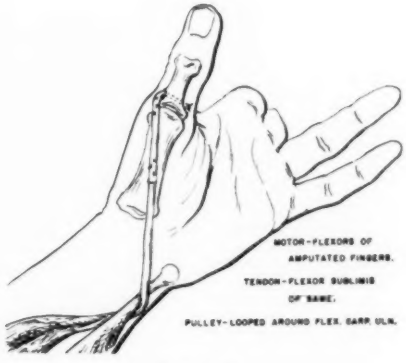

FIG. 4-F

Operation advised to restore ability to oppose the thumb. The two essential principles are: (1) The tendon should pull in the right direction,—namely, subcutaneously diagonally across the thenar eminence toward the pisiform bone to angulate the thumb forward and toward the ulna; (2) the insertion of this tendon should be into the dorso-ulnar aspect of the base of the proximal phalanx, so as to pronate the thumb. Then one may use whatever seems best in the individual case for motor power, tendon, and pulley. These drawings illustrate what muscle and tendon material may be used and ways of constructing the pulley.

tendon grafting will restore very good opposition if the following two major principles are adhered to.

TWO ESSENTIAL PRINCIPLES OF TENOPLASTY

The tendon from its insertion in the thumb should pass subcutaneously in the direction of the pisiform bone, so that it will pull the thumb in the correct direction, and the insertion of the tendon should be on the dorso-ulnar aspect of the base of the proximal phalanx of the thumb, so as to restore the pronatory component.

To make the tendon pull toward the pisiform bone, either a tendon pulley is constructed there or the tendon is looped around the distal part of the tendon of the flexor carpi ulnaris. There will then be a similar arrangement to that found anatomically in the omohyoid or the tensor veli palatini muscles.

The first case in which the author used these principles was reported in *Surgery, Gynecology and Obstetrics* in September 1924. His series of forty-six cases has convinced him of the correctness of these principles. Many other methods have been reported by the use of which excellent results have been claimed. From the illustrations in these reports, however, it is evident that the conception of true opposition was not as expressed here. No operation where the tendon passes under the transverse carpal ligament can possibly produce true opposition, as the tendon does not pull in the right direction. It merely pulls the thumb into the palm and not out forward from it.* Also, if a

FIG. 5

A splint of adhesive plaster to hold the thumb in position of opposition. A small pad protects the skin. The resultant of pull by the two arms of adhesive is in the direction of the pisiform bone. This splint is useful in protecting paralyzed thenar muscles and newly placed tendons and in bending stiffened joints into this functionating position, including increasing the carpal arch.

FIG. 6-A

FIG. 6-B

Miss S. P. Restoration of opposition of the thumb by suture of the tiny motor thenar branch of the median nerve. In this case the nerve was severed, as shown in Fig. 6-B, by surgical incision for drainage of the thenar space, which resulted in atrophy of the muscles and loss of opposition. The photograph was taken thirteen months later and shows the well-restored thenar eminence and restoration of ability to oppose the thumb.

* In some cases of poliomyelitis, as Ober has suggested, the transverse carpal ligament is so lax that a tendon passed under it might pull the thumb toward the pisiform bone.

FIG. 7-A

FIG. 7-B

Dr. E. S. Restoration of opposition of the thumb by suture of the median nerve at the wrist.

Fig. 7-A: From laceration at the wrist, both median and ulnar nerves and several tendons were severed, resulting in claw-hand with atrophy of the thenar muscles and complete loss of opposition and adduction of the thumb.

Fig. 7-B: Two years later function of the intrinsic muscles had been restored by suture of the median and ulnar nerves. The thenar eminence and other intrinsic muscles, as well as the ability to oppose the thumb, had been restored so that the patient was able to resume the practice of dentistry.

tendon is used for opposition, it should be for that function alone and should not have two insertions, each for a different function. Otherwise there will not be free and independent action in each of the two functions. If a flexor is used, the thumb cannot be flexed without opposing. The muscle transferred should be adequate in strength and its original function, if important, should not be sacrificed.

OTHER METHODS REPORTED

With these principles in mind, the author wishes to mention briefly the methods previously reported.

The first group represents methods in which the tendon is passed under the transverse carpal ligament:

Krukenberg split the flexor digitorum sublimis tendon of the long finger and inserted it in the radial half of the first metacarpal.

Roeren did the same with the flexor digitorum sublimis tendon of the ring finger.

Ney used the tendon of the extensor pollicis brevis detached above, and, after passing it under the transverse carpal ligament, joined it to the tendon either of the palmaris longus or of the flexor carpi radialis.

FIG. 8-A

FIG. 8-B

Mr. W. W. Extensive laceration of the hand and wrist eighteen months previously in which the median and ulnar nerves and several tendons were severed.

Fig. 8-A: Complete thenar atrophy and loss of adduction and opposition of the thumb and loss of abduction of the index finger.

Fig. 8-B: Extensive repair of nerves and tendons was done. Without waiting for the nerves to regenerate, the tendon of the extensor indicis proprius was sutured to that of the first interosseus muscle with restoration of abduction of the index finger. A pulley operation was then done on the thumb, in which the flexor carpi ulnaris was used as the motor power and a slip from it was used to construct the pulley. The tendon of the extensor pollicis brevis was withdrawn from the arm and transferred subcutaneously across the thenar eminence through the pulley and sutured to the flexor carpi ulnaris. In the photograph, taken only two months later, the tendon can be seen drawing the thumb two inches in front of the base of the index finger.

Lyle employed the same method, but, in addition, combined it with Steindler's operation on the flexor pollicis longus tendon.

The following are methods using the flexor pollicis longus tendon and also keeping the tendon beneath the transverse carpal ligament:

Steindler split the distal end of the flexor pollicis longus tendon in two and detached the radial half from its insertion, passed it around the radial side of the thumb, and reinserted it at the back of the base of the proximal phalanx.

Silfverskiöld risked the use of the whole flexor tendon of the thumb, transplanted it around the radial side of the thumb, and inserted it at the base of the proximal phalanx.

Whitehurch severed the flexor pollicis longus tendon, carried it around the radial side of the thumb, and resutured it.

Von Baeyer freed the insertion of the flexor pollicis longus, passed it around the radial side of the thumb, and reinserted it at its original insertion.

In the following methods the extensor tendons are used:

Jahn passed the extensor tendon of the third digit around the ulnar border to the volar side of the hand and inserted it into the first metacarpal. He repaired the defect with a free fascial transplant.

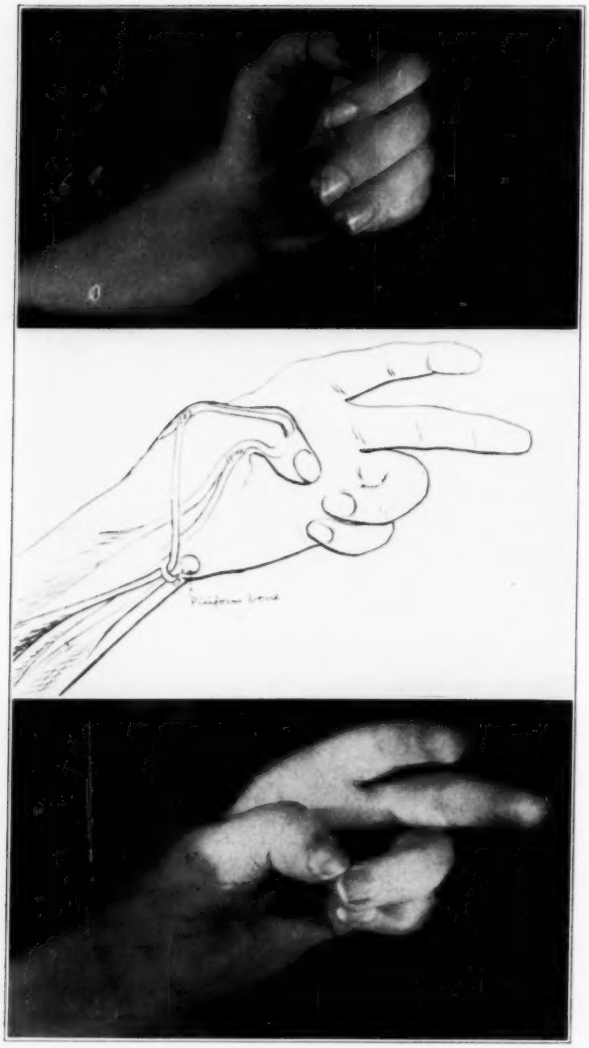

FIG. 9

FIG. 9

Miss M. V. Following poliomyelitis at the age of four, the thenar muscles atrophied and the patient could not oppose the thumb at all nor could she flex it. Also the extensor pollicis longus was too weak. The flexor digitorum sublimis of the ring finger was transferred to the flexor pollicis longus to furnish flexion. For opposition the palmaris longus, together with its extension, the palmar fascia, was passed through a pulley at the pisiform bone made from an extensor of the toe, and passed on subcutaneously to be attached to the tendon of the extensor pollicis longus. This restored ability both to extend and to oppose the thumb.

Upper: Limit of opposition preoperatively.

Middle: Tendon transfers.

Lower: Function of thumb, including restoration of opposition.

Cook's operation, as described by Taylor, consisted of passing one of the extensor tendons of the little finger around the wrist subcutaneously and inserting it into the first metacarpal.

Other miscellaneous methods are as follows:

Huber and Nicolaysen used the abductor of the fifth digit and fastened it to the first metacarpal.

Camitz inserted the tendon of the palmaris longus with some of the palmar fascia on the lateral side of the metacarpophalangeal joint of the thumb.

Kortzeborn used a fascial sling to fix the thumb in opposition, did a plastic operation on the palm, and lengthened the extensor tendons.

Spitzy, and also Baldwin, performed an arthrodesis on the carpometacarpal joint of the thumb.

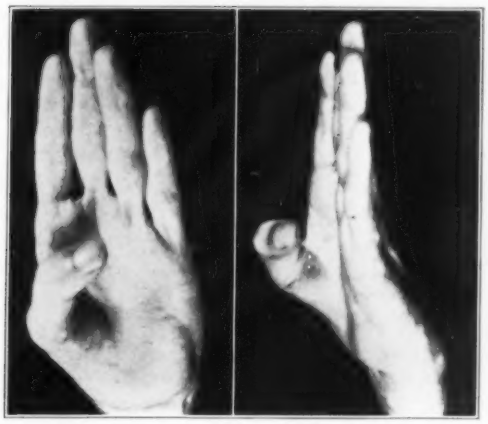

FIG. 10-A FIG. 10-B

FIG. 10-C

FIG. 10

Mr. P. C. A burn from a bottling machine destroyed the thenar eminence. This was covered by a pedicle skin graft.

The ability to oppose the thumb was restored by a tendon-transfer pulley operation. The tendon of the extensor pollicis brevis was detached at its muscle, withdrawn through an incision at its insertion, and then passed subcutaneously across the thenar eminence toward the pisiform bone. The tendon of the palmaris longus was detached at its insertion, looped about the tendon of the flexor carpi ulnaris for a pulley, and then sutured to the tendon of the extensor pollicis brevis.

Figs. 10-A and 10-B: Good opposition restored. The tendon pulling beneath the skin is apparent.

Fig. 10-C: Showing loss of the thenar eminence.

FIG. 11

Fig. 11-A: Mr. A. H. The median nerve had been severed at the wrist and was sutured three years previously, but without return of the thenar eminence or ability to oppose the thumb.

FIG. 11-A

Fig. 11-B: Mr. A. H. A tendon-transfer pulley operation promptly restored ability to oppose the thumb as shown in the hand with the atrophied thenar eminence and the sleeve rolled up.

The flexor carpi ulnaris tendon was split in two near its insertion. One half was used to make a pulley and the other was detached at its insertion and prolonged by a free graft from the tendon of the palmaris longus. This was passed through the pulley, across the thenar eminence subcutaneously, over the dorsum of the proximal joint of the thumb, and attached by a drill hole to the base of the proximal phalanx at its dorso-ulnar aspect.

FIG. 11-B

Foerster planted a three-centimeter bone graft from the tibia between the first two metacarpals.

TECHNIQUE OF OPERATION ADVOCATED

If the two main essential principles mentioned are adhered to, one has quite a varied choice in the selection of muscle and tendon and in the construction of the pulley, depending on which are available or advantageous in the particular case of reconstruction. Each hand is a problem in itself, and, as the parts injured differ, so we must adapt our procedure to the available material providing we adhere to these two simple principles,—namely, direction of pull and correct insertion to give pronation.

FIG. 12-A

Any of the following may be available:

For motor power, we may use the flexor carpi ulnaris, the palmaris longus, the flexor digitorum sublimis of the ring finger, or any available long flexor muscle. The extensor muscles

FIG. 12-B

FIG. 12-C

Mr. R. F. A porcelain faucet lacerated the thenar eminence, damaging the motor thenar branch of the median nerve beyond repair and thus paralyzing the abductor and opponens pollicis muscles, so that the patient could not oppose the thumb. The flexor tendon and the two volar nerves of the thumb were also severed. Four months later the flexor pollicis longus tendon was repaired by a free graft from the palmaris longus tendon, and the two sensory nerves were sutured. A tendon-transfer pulley operation was done to restore opposition. The tendon of the extensor pollicis brevis was detached at its muscle, withdrawn near its insertion, and then passed subcutaneously across the thenar eminence. Here it was passed through a pulley made from a free graft of the palmaris longus and was sutured to the tendon of the flexor carpi ulnaris which was detached from its insertion for the purpose.

Fig. 12-A: Showing the ability to oppose the thumb to two inches in front of the base of the ring finger and two and one-half inches in front of that of the long finger.

Fig. 12-B: The pronation and forward position gained.

Fig. 12-C: Atrophy of the thenar eminence. The original function of the flexor carpi ulnaris muscle has not been lost.

are rather weak for this purpose, and their course is long, thus presenting opportunities for the formation of adhesions.

In regard to tendons, the extensor carpi radialis brevis is excellent as it already has the correct insertion, and also will retain its original function

FIG. 13

Mr. T. T. Ability to oppose the thumb was lost by a wide excavation of a dado saw through the thenar eminence, which destroyed beyond repair the muscles and motor thenar branch of the median nerve.

Ability to oppose the thumb was regained by a tendon-transfer pulley operation, using the flexor carpi ulnaris muscle for the motor power. The tendon of the extensor pollicis brevis, which had been withdrawn from above, was passed subcutaneously across the thenar eminence and through a pulley at the pisiform bone. This pulley was constructed from a free tendon graft of the palmaris longus and was sutured to the tendon of the flexor carpi ulnaris. The latter was detached from its insertion at the pisiform for the purpose, but did not lose its function as is shown in Fig. 13-C. Opposition of the thumb was restored as shown in Figs. 13-A and 13-B. The atrophy of the thenar eminence shows in all three pictures.

FIG. 13-A

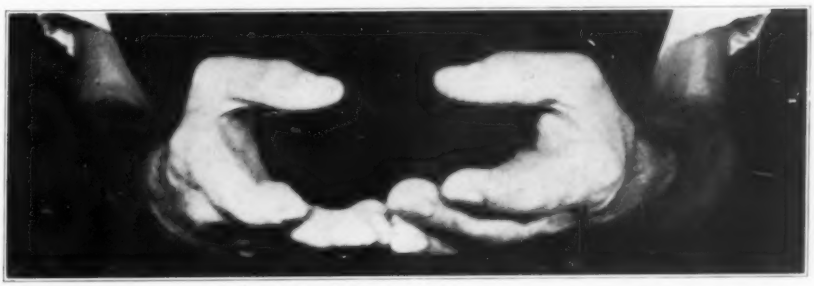

FIG. 13-B

FIG. 13-C

and can be sutured to another tendon just proximal to the pulley at the pisiform bone. Also, the palmaris longus can be prolonged sufficiently by using its prolongation, the palmar fascia, or any tendon desired can be pieced out by a free tendon graft either from the palmaris longus tendon or from any other tendon that may be available.

For the construction of a pulley at the pisiform bone, a free tendon graft either from the palmaris longus or from any other available tendon can be looped through the short muscle and tendon attachment to the pisiform bone and sutured to itself, so that it forms a circle two centimeters in diameter. The sutured junction is then slipped around until it is within the muscle.

Another method of making a pulley is to use one-half the thickness of the flexor carpi ulnaris tendon, severing one of the halves high and suturing this free end to the ligament of the pisiform bone to complete the loop.

Similarly, the tendon of the palmaris longus can be severed four centimeters above its insertion and made to act as a loop or pulley by suturing it into the pisiform ligamentous tissue, leaving its original insertion intact.

Instead of constructing a pulley, one can pass the tendon used around the flexor carpi ulnaris tendon and on to its insertion in the phalanx of the thumb. The flexor carpi ulnaris then aids in the opposition.

For the sake of clarity, a few concrete examples of the technique are shown in Figures 4-A through 4-F.

In the reconstruction there may be available some tendons of the long extensors of the toes or opposite the palmaris longus. With a free graft of one of these, a pulley can be made at the pisiform bone. The tendon of the palmaris longus is detached at its insertion and prolonged by a free tendon graft, passed through the pulley and then subcutaneously across the thenar eminence over the head of the metacarpal to be inserted through a drill hole in the dorso-ulnar aspect of the base of the proximal phalanx. Another method is to detach the tendon of the extensor carpi radialis brevis high, draw it out at its insertion, and then pass it subcutaneously across the thenar eminence to the pisiform bone. Here it is passed through the pulley and then sutured to the distal end of the tendon of the flexor carpi ulnaris. The flexor carpi ulnaris muscle is quite strong, and, if it is used to give the thumb opposition, its normal function of ulnar palmar flexion is not lost. Also, if the extensor pollicis brevis is used, the function of extension of the thumb is not lost.

CONCLUSION

The opposable thumb is valuable to man. A thumb in true opposition is not only opposite the fingers, but it is far forward from them and is rotated so that the pulp faces that of the fingers and the nail parallels the palm. Any tenoplasty to produce this must adhere to two essential principles. The tendon must pull subcutaneously in the right direction toward the pisiform bone and it must be inserted in the dorso-ulnar aspect

of the base of the proximal phalanx of the thumb to give pronation. This may be accomplished by using any of various muscles for motor power, and for the tendon either the extensor pollicis brevis tendon or any one of various tendons prolonged by tendon grafts. The tendon used is made to pull in the right direction either by passing it through a tendon pulley constructed at the pisiform bone or by passing it around the tendon of the flexor carpi ulnaris.

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DISEASES OF THE APOPHYSEAL (INTERVERTEBRAL) ARTICULATIONS

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This study has its origin in the commonplace observation that recurrent or persistent pain and stiffness in the spine are not always associated with demonstrable anatomical changes, and that well-marked spinal lesions may be found in the absence of any clinical symptoms. This discrepancy is not fully explained by the variable condition of the vertebral bodies, intervertebral discs, and spinal ligaments, or by disturbances in the functional correlation between the muscles and bones of the back.

Little is known in this connection about the behavior of the apophyseal joints. There are investigations on the pathogenesis and morbid anatomy of certain inflammatory and degenerative diseases (Beneke; Burckhardt; Eaton; Fischer and Vontz; Fraenkel; Güntz; Klinge; Schmorl and Junghanns; Shore; Simmonds; and Sivén); on their relations to systemic and traumatic affections of the spine (Beneke; Fraenkel; Knaggs; Lang; Lange; Schmorl and Junghanns; and H. Turner); on the roentgenographic technique involved (Dittmar; Ghormley and Kirklin; Jordan; and Lange); and on the correlation of roentgenological and anatomical findings (Bakke; Forestier, Coliez, and Robert; Robert and Forestier; Schmorl and Junghanns); but systematic studies on the interrelations between the clinical conditions and the underlying anatomical changes have not yet been published.

Significant incipient and transitional phases are met with on autopsy only very exceptionally; thus there is as yet no uniformity in interpretation of pathological findings in spondylarthritis. Clinically, affections of these articulations do not cause very distinctive local manifestations. Roentgenologically, some of the pathological structures involved are too radiolucent to produce definite shadows; [13, 26, 39] and the inaccessible position of the joints, their complicated structure, and their variable relation to the vertebral bodies render the articulations almost invisible on "routine" roentgenograms. They are, however, demonstrable by methods more recently developed, but, since the elaborate technique involved has not yet been generally adopted as a part of standard examinations of the spine, the observations are still too limited in number to allow consistent interpretation.

It is for these various reasons that the author's own findings are here submitted. They are the result of 1,000 roentgenographic examinations of the spine; of clinical and roentgenographic observations on 147 patients with various lesions of the apophyseal joints, many of whom have been reexamined at intervals during periods of from one to three years; and of

studies on the differences between anatomical and roentgenological findings. Special attention has been given to the following questions:

1. Can the diseases be classified anatomically or etiologically?
2. Are there demonstrable interrelations between certain clinical and distinct anatomical findings?
3. What are the relations between diseases of the apophyseal joints and affections of other elements of the spine?
4. Can treatment be directed by the results of such diagnostic evaluation?

ROENTGENOGRAPHIC ASPECT

The apophyseal articulations are the only true joints of the spine. Considered both as units and as a system of interlinked joints, they are fairly well separated from the anterior weight-bearing section of the column which is formed by the "axial elements",—that is, vertebral bodies, intervertebral discs, and longitudinal ligaments. Unlike the cancellous vertebral bodies, the articular processes, as parts of the arches, consist of compact bone.

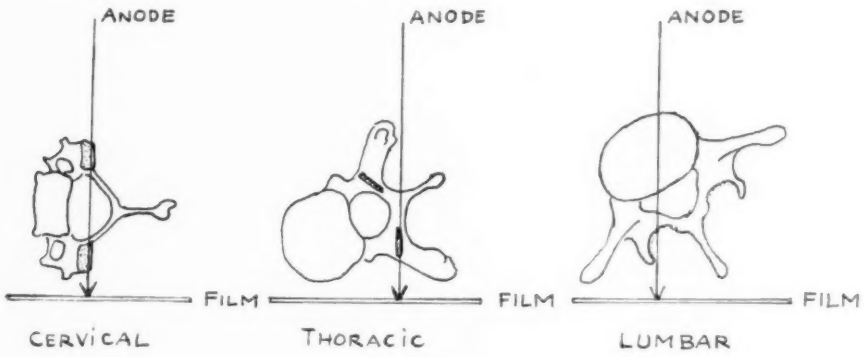

FIG. 1

Positions for roentgenographic demonstration of the *left* apophyseal articulations. The arrows indicate the direction of the central ray.

The superior and inferior articular processes are the parts of one bone which, having no anatomical designation, is here called "articular segment"; its center, from which the articular processes originate, is the interarticular portion. Each articular process has a facet covered by cartilage; the joint space between them normally varies in width and amount of synovia.[18] The anterior portion of the capsule forms the posterior border of the intervertebral foramen through which the corresponding spinal nerves pass; its posterior part is covered by the ligamentum flavum. The other periarticular ligaments are of little importance pathologically.

The articular surfaces vary in position and shape in the several regions of the column. The relative positions of the patient, the tube, and the

film are shown in Figure 1. The roentgenographic technique is discussed in a separate report.

On physical examination in each case, the mobility of the spine was studied; also the type of pain possibly elicited by palpation and percussion, or by certain active and passive movements of the spine and limbs, especially backward stretching of the spine. A majority of patients had complete clinical and laboratory examinations in the hospital. A detailed history was obtained in all cases.

PATHOLOGICAL CHANGES

The apophyseal joints, being covered by thick layers of soft tissues, do not show, when diseased, such conspicuous signs as swelling or redness. The type of pain in the spine and its relation to posture and to certain movements may often give suggestions as to the underlying morbid condition;[34] but, since the diagnosis in most cases depends eventually upon the roentgenological findings, these are here taken as landmarks. The American terminology is followed in this report: "atrophic arthritis" corresponds to the British "rheumatoid", to the German "primary" or "*Infekt-arthritis*", and to the French "*arthrite*"; "hypertrophic arthritis", to "osteo-arthritis", to "*Arthrosis*" or "*Osteo-arthropathie*", and to "*arthrose*", respectively.

These anatomical designations are here used because, being the simplest, they afford the most satisfactory basis for discussion, although obviously the purely anatomical view cannot take into account other aspects of the matter.

FIG. 2

Acute spondylarthritis. A defined soft shadow obscures the third cervical apophyseal joint space (arrow). No other changes are present.

The patient was a male, twenty-nine years old. He complained of pain in the neck, which radiated to the left elbow.

Atrophic Spondylarthritis

Atrophic arthritis, characterized by an inflammation affecting primarily the synovial membranes, occurs in the apophyseal joints in one of two main types,—namely, acute or chronic. The acute form has been found to be a strictly localized condition; the chronic develops into a distinctly systemic disease in typical cases, but may in others become arrested and then remain more or less localized.

Acute

Seven cases have been observed,—two males and five females; the youngest patient was nineteen years of age and the oldest thirty-seven.

Following an acute respiratory infection, dull pain, confined to a

FIG. 3

Acute spondylarthritis. The fourth and fifth cervical apophyseal joint spaces are obscured (black arrows), and there is slight generalized rarefaction of the corresponding articular processes (white arrows). Compare with the normal upper joint space and bones.

The patient, a female, aged twenty-eight years, had a low-grade fever, severe pain in the neck with marked rigidity caused by muscle tension, and severe pain in the right arm with complete disability.

small section of the spine, developed "over-night". In five cases, the cervical spine was affected; in two, the sacrolumbar region. Pressure upon the region involved elicited severe pain radiating into the arm or along the course of the sciatic nerve. A sensation of stiffness in the painful area was complained of. On examination, increased muscle tension in this area was evident, but the mobility of the spine was found free. No other joints were simultaneously affected.

Roentgenologically, no changes were found in two instances. In three cases, a homogeneous hazy shadow, extending slightly beyond the margins of the articular processes, obscured the apophyseal-joint space of the painful cervical articulation (Fig. 2). In one of these cases, both the bone structure and the outlines of the corresponding articular processes were normal. In the two other patients, the outlines of the facets were indistinct and the bone density of the articular processes was moderately diminished (Fig. 3). In all the cases, the discs and the vertebral bodies were normal. The shadow described corresponds in location and in size to the articular capsule; it is too small and too circumscribed to represent, for example, a thickened muscle. Its disappearance with subsiding clinical symptoms characterizes it as the expression of a transient swelling.

Two patients left the hospital before treatment was attempted. In two other cases, the symptoms subsided entirely within ten days under short-wave treatment over the diseased region. In the fifth case, there was a recurrence after seven weeks. Reexamination revealed chronic tonsillitis with pus in the very large tonsils. Following tonsillectomy, the symptoms subsided and have not recurred (seven months after operation).

In the sixth case, severe pain in the lower back associated with excruciating "sciatica", loss of reflexes, and muscle atrophy in the diseased leg had persisted for eleven months. In this patient, mottled demineralization of the left sacrolumbar articular processes and blurred outlines of the facets were found,[34] but the joint space itself was of normal width. Within forty-eight hours after removal of the inflamed tonsils, this patient was completely cured; at present, nineteen months after tonsillectomy,

he is in perfect health, but the articular processes involved are still a little less dense than on the normal side. In the long duration of the disease, as well as in the marked involvement of bony parts, this case differs in degree from those preceding it.

The condition here discussed is marked by a localized, usually monarticular inflammation in an apophyseal joint. The normal width of the articular spaces indicates that the cartilages remain intact. Accordingly, restoration to normal is still possible. The articular affection was associated with acute respiratory infection and, in two cases of longer duration, with chronic tonsillitis. A causative correlation with this focal infection was made very probable by the immediate and lasting result of tonsillectomy.

None of the patients had symptoms of rheumatic fever; the presence of definite anatomical alterations in the absence of noticeable general symptoms stands in contrast to this polyarticular affection. Nevertheless, rheumatic fever and acute phases of atrophic arthritis may "differ in degree rather than in kind".[36] The condition is best termed "acute spondylarthritis" (*spondylos* = vertebra; *arthron* = joint); since hypertrophic arthritis is never acute, it would seem unnecessary to add "atrophic".

Chronic

Chronic atrophic arthritis is characterized by destruction of articular cartilages,—an irreparable lesion, for cartilage cannot be regenerated. Hence the distinction between acute and chronic atrophic spondylarthritis is here not based upon the duration of the clinical symptoms, but is determined by the absence, in the former, of destruction of cartilage.

FIG. 4-A

FIG. 4-B

Chronic atrophic spondylarthritis. The space between the left fifth and sixth cervical articular processes is much narrower (arrow) than the right. Amoebiasis. Case referred to in text.

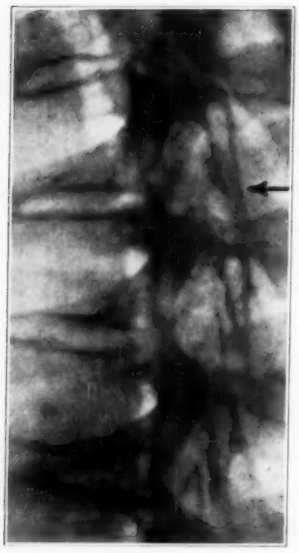

FIG. 5

Chronic atrophic spondylarthritis. The fifth thoracic apophyseal joint space is narrowed (arrow); the superjacent articular process is thinner and less clearly defined than in the lower normal joints.

The patient, a female, aged thirty-two, complained of pain in the back, which radiated along the intercostal nerve. Rotation to the left was impaired, and rigidity of the thoracic spine was present. There was no fever.

Roentgenologically, therefore, the differentiation is made according to the width (normal or diminished) of the involved joint space. It is obvious that destruction of cartilage narrows the joint space.

At this stage (while still uncomplicated by secondary changes to be discussed later) the disease is rarely observed. The author has seen four cases.

A merchant, forty-two years of age, complained of severe pain in the left portion of the neck, followed after a week by stabbing sensations in the left shoulder, elbow, and hand, and numbness of the left finger tips. These symptoms had begun after a "chill" nine weeks previously. Raising the left hand behind the neck caused pain in the neck and the shoulder. There were no other symptoms except low-grade fever. Clinically, there was very marked persistent tension of the extensors of the left side of the neck. The cervical spine was held stiff and straight; rotation was slightly impaired, and forward bending (both active and passive) was impossible. Percussion of the spinous processes did not elicit any sensation, but pressure upon the fifth and sixth cervical vertebrae, four centimeters to the left of the posterior mid-line, caused moderate pain locally and severe radiation into the left shoulder, with tingling in the finger tips. Roentgenographically, the space between the left fifth and sixth cervical articular processes was narrowed as compared with the right side (Figs. 4-A and 4-B). There was no demineralization of articular processes and no calcification of ligaments. The facets involved were parallel in position. Because endamoeba histolytica was found in the stools, antiamoebic treatment was given, with the result that the temperature became normal and spontaneous pain subsided within four days. Twelve days after the first examination, there was no longer any pain or muscle tension; nevertheless, the mid-cervical spine was rigid, and the involved joint space was as narrow as before.

In two other patients with chronic tonsillitis, pain and rigidity of the section involved were found associated with narrowing of the cervical and lower thoracic articular spaces. No other joints were affected, and there were no "rheumatic" manifestations. In the fourth case, the thoracic articular processes adjacent to the narrowed joint spaces were slightly rarefied (Fig. 5). This patient had chronic amoebiasis.

The significance of these findings will be discussed together with those characteristic of ankylopoietic spondylarthritis.

Ankylopoietic Spondylarthritis

This is a typical atrophic arthritis (as proved histologically [14, 18, 42]), with a marked tendency toward systemic involvement of all of the apophyseal articulations and demineralization of the vertebral column.

Eleven cases have been observed (nine males and two females). The symptoms varied in intensity according to the stage of the disease and to the extent of the involvement. The patients stated unanimously that pain in various regions of the spine had followed some acute infection. The spinal section involved had become stiff; pain and rigidity had extended gradually to other parts of the spine; and radiating pain into the extremities had accompanied these symptoms at irregular intervals. The clinical aspect is unmistakable: the region involved, and sometimes the whole spine, is perfectly rigid and at the same time straightened; the neck is fixed in a position of forward extension, and there is an angulation at the junction of the thoracic and cervical portions. Movements such as rotation or bending forward are performed by means of other joints,—the patient turns on his feet, and he bends forward by flexing at the hip joints, whereby the spine retains its rodlike straightness. Often the leg cannot be elevated unless bent at the knee joint as in sciatica (Lasègue's sign), but without the sciatic pain. (See Figures 6-A, 6-B, 7-A, and 7-B.)

Roentgenographically, in the early stages, the articular spaces affected are narrowed (Fig. 8-A); simultaneously, the articular processes appear demineralized. The facets remain parallel in position, and the section involved, losing its physiological curve, is straightened. Very soon (within from three to four months) the vertebral bodies also may decalcify, so that all the bone elements of the diseased portion increase in radiolucence (Figs. 8-A and 11-D). In the course of not less

FIG. 6-A

FIG. 6-B

Ankylopoietic spondylarthritis confined, at present, to the lumbar spine.
Fig. 6-A: Maximum degree of forward bending of which the patient is capable.
Fig. 6-B: To reach the floor with the finger tips, the patient is obliged to bend the knees.
The patient, a merchant, aged thirty-nine years, gave a history of pain in the lower back of four years' duration, intermittent sciatica, and gonorrhoea. At present, there is no pain, but rigidity of the lumbar region is present. There is no fever. Lasègue's sign is positive in the absence of any sciatic pain.

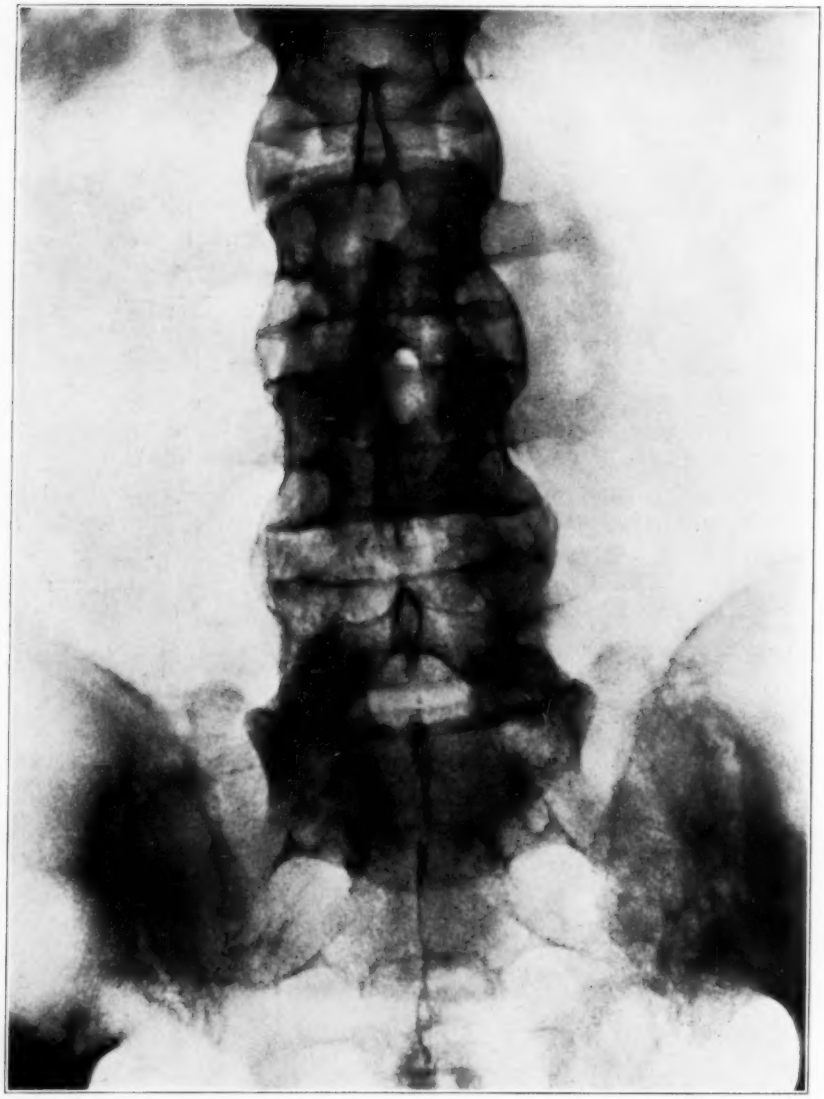

FIG. 7-A

Lumbar spine of patient shown in Figs. 6-A and 6-B. Bamboo spine. Involvement of the sacro-iliac articulations.

than six months the outlines of the facets become irregular; after this time they are no longer recognizable. Again, within not less than about twelve months, bone substance of perfectly regular structure fills the original joint space; under exceptionally fortunate circumstances, one is able to observe this new bone forming at the facets and growing slowly from either facet into the narrowed joint space (Figs. 8-B and 10). When this bony ankylosis is complete, adjoining articular processes are no longer distinguishable, for the whole region involved shows bony fusion of the

apophyseal joints. This finding is the criterion of ankylopoietic spondylarthritis.

The view here presented differs from that commonly expressed in the literature. The roentgenological findings upon which it is based, however, are consonant with early anatomical investigations (Fraenkel, Leri, Simmonds, and Sivén) that have recently been confirmed in every detail.[18] It seems, therefore, that ankylopoietic spondylarthritis is a typical atrophic arthritis of the apophyseal joints.

Secondary changes may occur subsequent to this inflammation, although not of necessity always associated with it. These secondary changes consist in ossification of ligaments, especially of the ligamenta flava (Fig. 9) which histologically participate in the inflammatory proliferation of the synovial membranes.[14, 18] Calcification of spinal ligaments is a very common and totally uncharacteristic response to a great variety of vertebral lesions,—inflammatory, degenerative, destructive, or traumatic. The ossified longitudinal ligaments, when tangentially projected, [13] the increased radiolucence of the bodies, and the rodlike ankylosis combine to give the appearance of a "bamboo spine". The intervertebral spaces, with normal discs, represent the nodes of the bamboo. The calcified ligaments appear stretched rather than tortuous as in diseases associated with thinning of the discs. Slight widening of the intervertebral spaces [33] occurs occasionally, indicating that the discs, remaining normal, compress the rarefied vertebral bodies.

FIG. 7-B

Lumbar spine of patient shown in Figs. 6-A and 6-B. Only one apophyseal joint space is clearly distinguishable (arrow); the others are filled with bone substance. The longitudinal ligaments are ossified.

Admirably described by the discoverers, Marie and Leri, the combination of systemic bony ankylosis of the facets with ossification of the ligaments corresponds to the clinical entity, *spondylose rhizomélique*. Because of the very marked degree of ligamentous calcification characteristic of advanced phases, some authors [38, 41] regard this disease as a

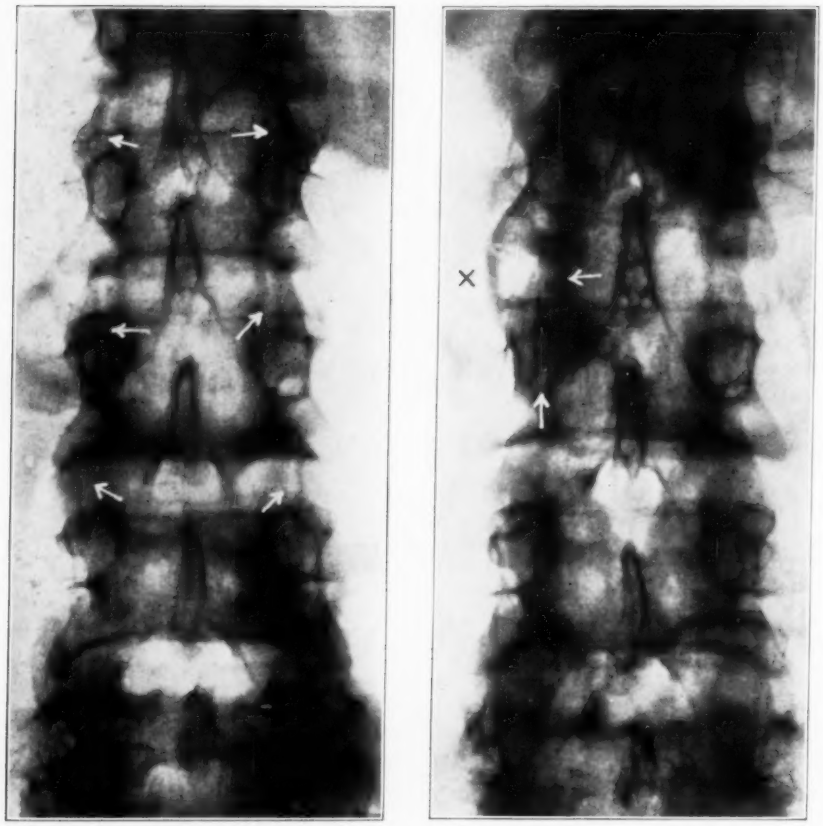

FIG. 8-A FIG. 8-B

Ankylopoietic spondylarthritis. Roentgenograms of lumbar spine.

Fig. 8-A: The apophyseal joint spaces are still visible (arrows), but the articular processes are rarefied and the facets are ragged.

Fig. 8-B: Twenty-nine months later. Ankylosis has taken place in all but one joint (arrows), and parts of the longitudinal ligaments have ossified (*x*). Note that the bone density of the vertebral bodies is less diminished than in Fig. 8-A, showing that rarefaction is more pronounced in the inflammatory stage than during the ankylosing phase.

The patient, a female, aged thirty-one years, has had pain and stiffness of five years' duration.

special "syndesmotic" type of chronic arthritis. Others [24, 36] have classified *spondylose rhizomélique* as a form of spondylosis ossificans ligamentosa. The latter condition, however, is determined anatomically by systemic ossification of the ligaments in the absence of changes of discs and apophyseal joints. Usually discovered accidentally in persons over fifty years of age during examinations of the chest, these changes are not associated with clinical symptoms. The posture is not altered (Fig. 11-A). Invariably, the apophyseal joints remain normal (Fig. 11-B). The thoracic spine is commonly the seat of the most extensive calcification, and the more mobile cervical and lumbar sections are less involved, wherefore mobility is usually intact. Radiating pain in the extremities is never

FIG. 9

Oblique view corresponding to Fig. 8-B. There is ossification of the ligamenta flava (arrows). The lower two joint spaces are still visible, but narrow; their facets are ragged. The hazy shadow covering one intervertebral space (*x*) corresponds to the ossified longitudinal ligament shown in Fig. 8-B.

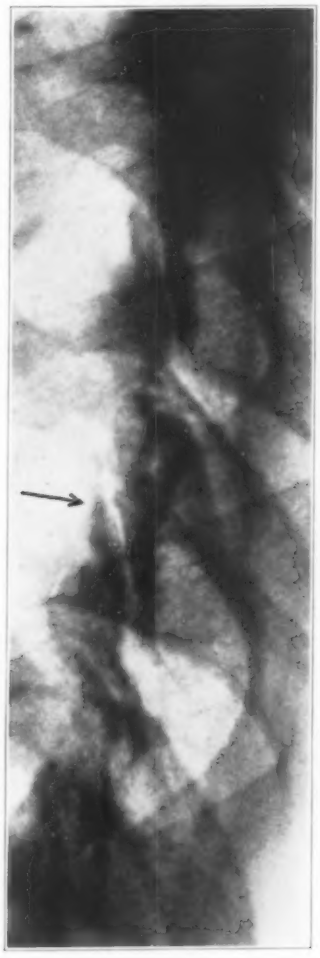

FIG. 10

Ankylopoietic spondylarthritis. The thoracic apophyseal joint spaces are narrowed and their facets are ragged (arrow). The patient was a male, fifty-seven years old, with persistent herpes zoster and rigidity of the thoracic spine.

observed, unless the condition is associated with some other changes of a different nature. In a localized type of spondylosis ossificans, only the ligamenta flava calcify,[2] but even then the apophyseal articulations are found intact (Fig. 12).

In ankylopoietic spondylarthritis, ossification of the ligamenta flava usually occurs during the period at which ankylosis becomes bony, as made evident by oblique dense lines at the posterior borders of the ankylosed joints. On the other hand, the longitudinal ligaments often calcify in a section of the spine distant from the seat of ankylosis.

FIG. 11-A

FIG. 11-B

Difference between spondylosis ossificans ligamentosa (Figs. 11-A and 11-B) and *spondylose rhizomélique* (Figs. 11-C and 11-D). The patients have been photographed in their accustomed posture.

Figs. 11-A and 11-B: Spondylosis ossificans: normal posture; pronounced ossification of longitudinal ligaments (*x*) and normal apophyseal joints (arrows); normal vertebral bodies and intervertebral spaces.

Figs. 11-C and 11-D: *Spondylose rhizomélique:* characteristic posture; spine stiff and flexion of thigh on diseased hip; apophyseal joint spaces ossified (arrows) and vertebral bodies greatly demineralized; ossified ligament (*x*); typical ankylopoietic spondylarthritis.

This series shows how little the two diseases have in common.

However, only when ankylosis of the most affected part is complete do all the ligaments, including the ligamenta interspinalia, ossify as a whole. If this "*rideau osseux*"[7] (bony curtain) becomes very dense, the apophyseal articulations are overshadowed and no longer distinctly visible, but this is quite exceptional. It would seem evident, then, that spondylosis ossificans ligamentosa is not to be confused with spondylarthritis ankylopoietica.

In the latter condition, rigidity does not depend upon actual ankylosis of the facets, but is well marked as soon as cartilage is destroyed. This suggests that it is the inflammatory rather than the subsequent ankylosing process which leads to stiffness, as in atrophic arthritis.

Quite commonly the whole of the spine is not involved equally and simultaneously; therefore, various phases of the disease overlap in the selfsame person before ankylosis is complete. The process may remain confined to one part of the spine for many years (Figs. 7-A and 14) or even for the entire lifetime, in which case demineralization seems less pronounced (Fig. 14).

FIG. 11-C

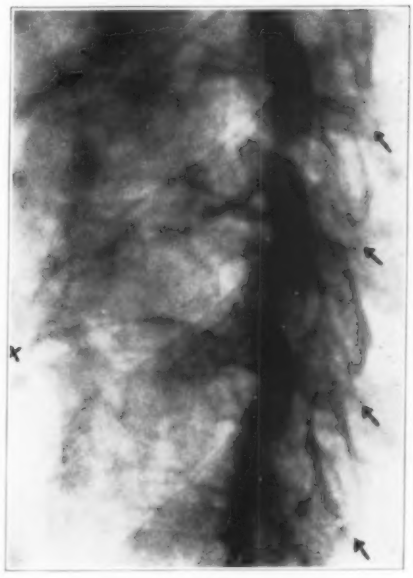

FIG. 11-D

The intervertebral foramina may be reduced in width to less than one-half of their original diameter (Fig. 13) by concentric calcifications.[32] At earlier stages, the swollen capsule also may compress the nerve roots. Whether or not such constriction will lead to actual compression of the nerves depends on the relation between the width of the foramina and the caliber of the nerves, for, as previously mentioned,[32, 34] radiculitis is more common in diseases of the lower cervical and lower lumbar spine, where the thickest nerves pass through foramina not wider than those in the neighboring regions.

Relations to other "rheumatic" affections have been reported,—for example, iritis[44]; and it is well known that arthritis of the costotransversal joints[14], of the sacro-iliac articulations[16], of the hips and shoulders[27, 28], and of the hands or feet[43] is sometimes superadded. The sacro-iliac joints were found affected within one year after the onset of spinal rigidity in ten out of eleven patients; the costotransversal joints, in three cases more than five years after the condition of the spine had been discovered; and the hip joints, one knee,

FIG. 12

Spondylosis ossificans ligamentosa localisata (Bakke). Only the ligamenta flava are ossified (arrow). The apophyseal joints are free.

FIG. 13

Ankylopoietic spondylarthritis. Ossification of all the ligaments. Constriction of one intervertebral foramen by concentric ossification (arrow). The apophyseal joints are ankylosed and are not distinguishable.

and one foot, in one patient three years after ankylosis of the whole lumbar spine had taken place. On the other hand, in chronic atrophic arthritis involving, for example, the hands, the elbows, the knees, and the feet, the author has not been able to find similar changes in the column. The variable etiology of these diseases may play a part in determining the inconstancy of these interrelations.

It would appear justifiable perhaps to consider the three types of atrophic spondylarthritis—acute, chronic, and ankylopoietic—as phases of a single continuum without assigning to any single one or to all of them a specific cause. The pathological findings described may be the expression of reactions of these areas to stimuli of a number of kinds, but the reaction may stop at any point, or it may continue to the stage described as ankylopoietic spondylarthritis.

Hypertrophic Spondylarthritis

Roentgenologically, hypertrophic arthritis is determined by increased bone formation within and around the articular surfaces. Hence the roentgenological determination differs of necessity from the anatomical. The primary lesion is localized in the cartilage, and this obviously causes the narrowing of the joint space seen in the roentgenogram,—either uniform, as in destruction of the entire cartilaginous layer; or irregular, as in partial destruction. Both may be masked by articular effusion, which is common in the disease.

Inflammatory osteoporosis (rarefaction) of the adjoining epiphyses, typical of atrophic arthritis, is not characteristic of the hypertrophic form. However, since hypertrophic arthritis is frequently the eventual outcome of some low-grade infectious (atrophic) arthritis,[13, 48] hypertrophic and atrophic changes may become superimposed.

In the apophyseal articulations, the disease occurs in one of two independent forms,—primary, and consecutive to postural alterations.

Primary Hypertrophic Spondylarthritis

Fourteen cases have been observed,—nine males and five females, all over fifty-three years of age. In three cases, the spine was examined because of herpes zoster that had persisted or recurred during four, seven, and eleven months respectively; in three others, examination was made

because of pain in the neck and the shoulder girdle; but in the remaining eight patients, the condition was discovered accidentally, and no clinical symptoms were associated with it. In thirteen of the cases, endamoeba histolytica was found in the stools.

Roentgenologically, the thoracic spine was found to be affected in seven cases, the lumbar spine in three, and the cervical spine in four. The articular processes were greatly increased in density; the facets were ragged; the apophyseal joint spaces were irregularly narrowed; and there were thorn-shaped exostoses at the posterior borders of contiguous facets (Figs. 15-B, 15-C, and 15-D). These changes were confined to one articulation in five cases, and to two or three joints in three cases; while, in the others, the whole cervical or thoracic spine was involved. The intervertebral spaces were normal, which shows that the discs were not affected; the vertebral bodies were intact; and there was no abnormality of posture. In three cases, parts of the anterior longitudinal ligaments were calcified.

Hypertrophic Spondylarthritis in Abnormal Posture

Eburnation and exostoses may develop wherever abnormal mechanical stress persists after having caused damage to the cartilages or bones upon which it acts.[4, 26, 39] In the spine, eburnation and exostoses develop in vertebral *bodies*,—for example, when abnormal contact between them or tension upon ligaments is produced by thinning of the intervertebral discs, [4, 32, 39] and in abnormal positions resulting from fractures, scoliosis [26], and the like.

Similarly, increased bone density and exostoses may develop in the *articular processes* when the articular cartilage has thinned down as a consequence of persistent pressure upon it,—for example, when by thinning of the intervertebral discs (traumatic or degenerative) the subjacent (superior) articular process is displaced forward,[32, 35, 50] or when deviation of the spinal axis in scoliosis or fractures causes compression (unilateral or circumscribed) of apophyseal cartilages.[26]

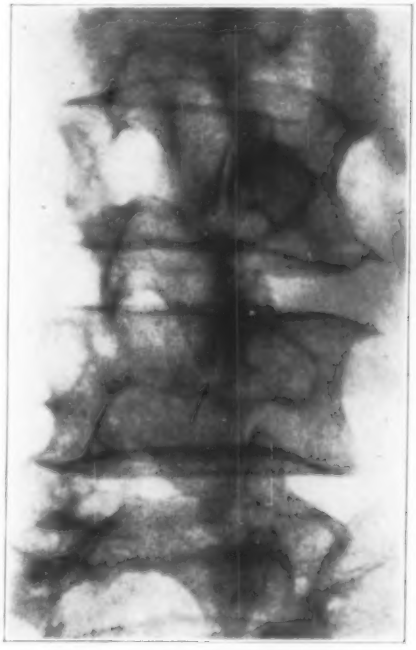

FIG. 14

Ankylopoietic spondylarthritis arrested and localized. There is bony ankylosis of one apophyseal joint (arrow) and the adjacent joint spaces are greatly narrowed. Thorn-shaped prominences at the margins of the vertebral bodies are present, indicating partial ossification of their longitudinal ligaments.

The patient, a teacher, aged fifty-seven years, gave a history of pain and stiffness about twenty-five years previously. The pain had subsided entirely after five years, but slight stiffness persisted. Only the lumbar region was involved.

FIG. 15-A

FIG. 15-B

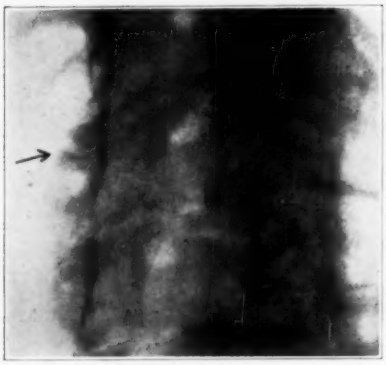

FIG. 15-C

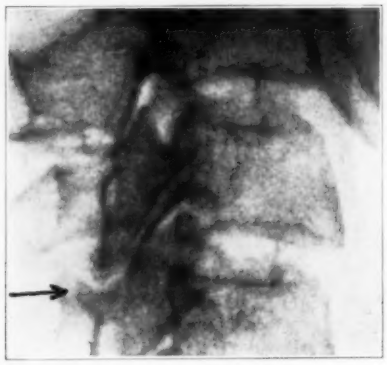

FIG. 15-D

Fig. 15-A: Normal lumber apophyseal joints.
Figs. 15-B, 15-C, and 15-D: Three cases of primary hypertrophic spondylarthritis: joint spaces narrowed; facets ragged; articular processes greatly increased in density and deformed by exostoses (arrows). Ankylosis by fusion of exostoses in one lumbar joint in Fig. 15-B indicated by *x*. Intervertebral spaces and vertebral bodies normal. Three cases of chronic amoebiasis.

Roentgenologically, increased density and exostoses appear mainly at the tips of the displaced facets. In the lower lumbar articulations, increased density of the articular processes is normal, because the overlapping of the cylindrical facets and the superimposition of the iliac bone

produce, in the oblique view, a summation of bone shadows (Fig. 15-A). By the ragged outlines of the facets and the narrowing of the joint space, the abnormal joint can be distinguished from the normal joint (Figs. 15-B and 15-C). Pathological bone formations of contiguous facets may fuse.[26, 39] This results in a type of bony ankylosis distinguishable from that found in ankylopoietic spondylarthritis by the absence of general rarefaction and the presence of residual exostoses. The facets, in all these conditions, are *not* parallel in position, their displacement being one of the primary causes of the whole process.

In the sixty-one cases observed, the clinical symptoms were those commonly found correlated with the condition underlying the displacement of the facets. Pain, localized or radiating, was the chief complaint. In most cases it was more pronounced during rest, especially in the small hours of the night when the patients, after a long period of sleep,

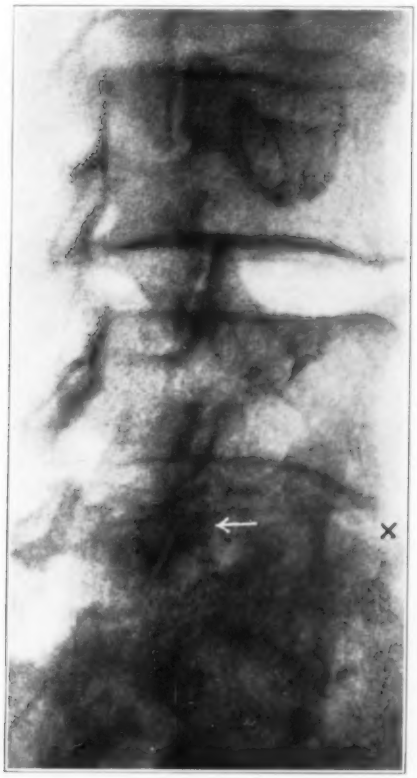

FIG. 16-A

"Discogenetic" hypertrophic spondylarthritis. The intervertebral spaces are narrowed (*x*), indicating thinning of the corresponding discs. The apophyseal joint spaces at this level are greatly narrowed, and their facets are ragged (arrows). Exostoses are present. There is superior displacement of the subjacent articular processes.

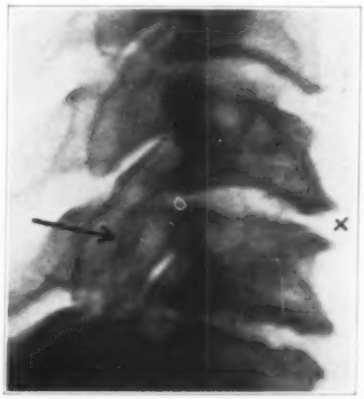

FIG. 16-B

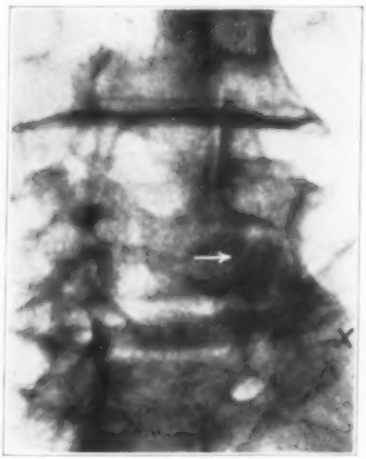

FIG. 16-C

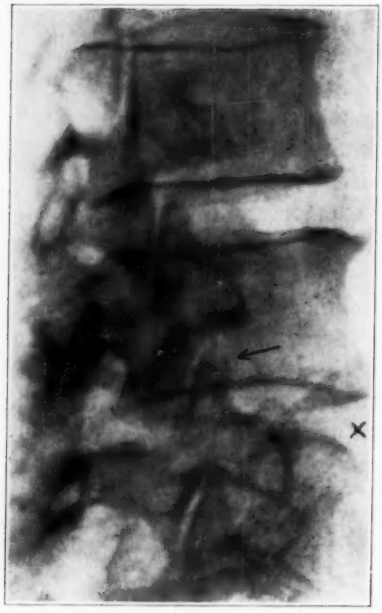

FIG. 17

"Discogenetic" disease. The intervertebral space is narrowed (*x*). There are no changes at the vertebral bodies, but upward displacement of the subjacent articular process (arrow) has occurred, with narrowing of the apophyseal joint space and increased density of the articular processes.

would be awakened by "rheumatic" pain in the shoulders, the arms, the lower back, or the neck. A sensation of stiffness, most marked in the early morning, commonly interferes with washing and dressing; in the course of the day both pain and stiffness become less acute. Rigidity was most pronounced in three cases, in which one articular process, impinging upon the adjacent vertebra,[32, 34] was surrounded by a broad area of intensively increased bone density (Figs. 15-C and 16-C).

The inconstancy of the relations between hypertrophic spondylitis (a disease characterized by exostoses at the margins of the vertebral *bodies*) and hypertrophic spondylarthritis has been repeatedly discussed.[18, 26] In fact, changes in the apophyseal joints were evident in only 14 per cent. of our cases of hypertrophic spondylitis. This is not surprising, for the apophyseal joints differ in both structure and function from the intervertebral synchondroses that are formed by the discs and the adjacent vertebral surfaces. The vulnerability of the articular cartilage[4, 48] is variable in different persons; therefore, mechanical stress does not of necessity lead in every instance to lesions of cartilage inducing arthritis. Hypertrophic spondylitis is very often the result of lesions of the discs; this was shown as early as 1824.[49] On the other hand, thinning of the discs does not invariably lead to increased bone formation at the vertebral bodies (Figs. 16-A and 17). Similarly, the abnormal stress upon the facets in this condition does not of necessity induce lesions of cartilages. It would seem that both the vulnerability of the cartilage and the readiness of the bone to respond by formation of exostoses are important factors in the pathogenesis of these conditions.

This is shown by those instances in which no bone reactions develop at both the vertebral bodies and the articular processes, in spite of marked thinning of the discs, contact between the bodies, and pronounced thinning of the articular cartilages (Fig. 17). In these cases, none of the characteristics of hypertrophic arthritis become evident roentgenographically, for only the intervertebral and the joint spaces seem to be affected; the bones are not involved. On the other hand, in thinning of the discs, enormous exostoses at the corresponding vertebral bodies may be found

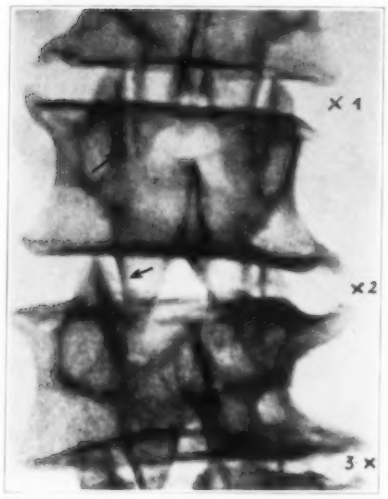

FIG. 18-A

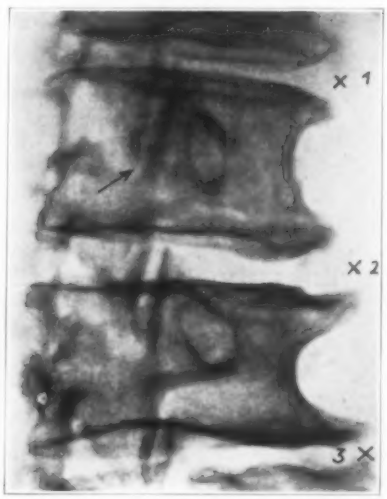

FIG. 18-B

"Discogenetic" hypertrophic spondylitis of the upper lumbar spine. Anteroposterior and oblique views. There are large exostoses at the vertebral bodies adjacent to the narrowed intervertebral spaces (*x*), but no changes in the apophyseal joints (arrows).

in the absence of narrowing of the apophyseal joint spaces and of any changes in the facets. This indicates that the vertebral bodies did respond to the abnormal mechanical stress produced by the thinning of the discs (Figs. 18-A and 18-B), but the cartilages resisted.

Regardless of the presence or the absence of these secondary changes, thinning of the discs is the cause of their eventual development, for it leads to contact between vertebral bodies, to abnormal tension upon ligaments, to displacement of articular processes, and to narrowing of the intervertebral foramina. The totality of these alterations has previously been referred to as "discogenetic disease",[32, 35] and for this reason the type of spondylarthritis that may develop in the course of the lesion is here designated as the "discogenetic" form of hypertrophic spondylarthritis.

Secondary Infection

Seventeen cases have been observed. In fourteen instances, tuberculosis of the vertebral bodies involved the articular processes; in three cases, an inflammation associated with condensation of the vertebral bodies (hypertrophic spondylitis) had spread to the articulations, as made evident by increased density of the articular processes. The joint spaces involved were found to be narrowed in all these cases. Persistent pain, impaired mobility, and rigidity of the segment involved were the main clinical symptoms. Tuberculosis, infection with brucella[26], osteoperiostitis[20], and osteomyelitis of vertebral bodies[26] have been reported to involve the articular processes. This is a rare occurrence,—in only fourteen out of eighty-one cases of Pott's disease was definite evidence of

FIG. 19-A

FIG. 19-B

Pott's disease. Collapse of lumbar vertebrae (*x*).
Fig. 19-A: The articular processes are not involved (arrow).
Fig. 19-B: There is slight rarefaction of the articular processes of the diseased vertebra, with indistinct outlines of the facets and blurring of the corresponding joint spaces (arrows).

articular involvement found. Even when the vertebral bodies have thinned down to a few millimeters in height, the articular processes may remain intact (Fig. 19-A). As long as the discs are not affected, they expand into the bones that have grown soft[39], thereby maintaining the normal distance between the articular processes and hence between the cartilages. Similarly, in systemic rarefaction inducing collapse of the vertebral bodies[33], or in vertebra plana (Calvé), the articular processes are rarely involved (Fig. 20). Consequently, the clinical symptoms are commonly mild as compared with the pronounced anatomical changes. One finds quite a number of patients with vertebrae destroyed by fractures, tumors, or infections, who have practically none of the clinical symptoms typical of spinal lesions.

FIG. 20

Platyspondylia aortosclerotica. There is flattening of the vertebral body (*x*), but no changes in the articular process (arrow) are visible.

Traumatic Lesions

Fractures of articular processes are not very common; the author has seen four cases. Both the fracture line and the displacement are easily recognizable in roentgenograms taken in the oblique position, or in lateral views of the cervical spine (Fig. 21). The callus formations, if any, are very

small. Three patients, after a fall, had developed segmental neuritis, without being conscious of a spinal lesion; the fourth had severe pain in the spine and marked rigidity, but this was probably due to a coexisting hypertrophic spondylarthritis.

Isolated Rarefaction of Individual Articular Segments and Articular Processes

Demineralization, irregular bone structure, and decrease in height of one articular process or of the two processes that form one articular segment have been observed in eight cases in the absence of any demonstrable changes in the corresponding joint spaces, the vertebral bodies, and the discs (Fig. 22). In one case recently observed, the adjacent facet was found slightly deformed by exostoses surrounding the area opposite the tip of the diseased articular process; in other instances, the superjacent process seemed to impinge upon the softened bone.[31] In six of the eight cases, the lesion affected the sixth inferior cervical articular process which, as previously reported[34], is often normally smaller and thinner than the adjacent processes, and is particularly liable to compression by the superjacent and subjacent processes during backward movements of the neck.

FIG. 21

Fracture of cervical articular process (arrow), the result of an accident two years previously. There is no pain in the spine, but the patient complains of tingling in the left finger tips. There is atrophy of the left interossei.

The lesion is invariably associated with severe radiculitis. There is no rigidity. The etiology is unknown; neither trauma nor malignancy has been involved.

Tumors and Osteitis Fibrosa

Destruction or erosion of the articular processes may be caused by various tumors (Fig. 23). In a case of Hodgkin's disease the author has found infiltration of the thoracic articular processes, as confirmed by autopsy, to be associated with persistent herpes zoster. In one case of osteitis fibrosa the articular processes were involved, but the joint spaces were normal. There was no rigidity.

Anomalies

Congenital aplasia of articular processes is rare. Differences in size and shape are common. Lack of bony union with the epiphysis forming the tip of the process appears as a radiolucent horizontal gap sometimes mistaken for a fracture line. None of these conditions is associated with clinical symptoms.

FIG. 22

Isolated rarefaction of one cervical articular process. The joint spaces and vertebral bodies are normal. There is severe radiculitis with trophic lesions in the left hand.

FIG. 23

Neurofibroma. Note destruction of the articular processes. There is palsy of the right arm.

Gaps in the interarticular portion (Fig. 24), the center of the articular segment, are responsible for spondylolisthesis;[39] the clinical symptoms vary according to the degree of both anterior displacement and reactive changes.[26]

CLINICAL AND ANATOMICAL INTERRELATIONS

When attempting to correlate the clinical with the underlying anatomical conditions, one is faced, at the outset, by the fact that anatomical lesions of the apophyseal articulations are not always associated with clinical symptoms. The significance of this statement, however, is limited by factors illustrated in the following case histories:

CASE 1. A. B., female, aged fifty-four years, a teacher, was first seen on November 11, 1935. Roentgenographic examination of the genito-urinary tract revealed narrowing of the fourth lumbar and lumbosacral spaces and eburnation and marginal exostoses of the fourth and fifth lumbar vertebral bodies, with marked eburnation of their articular processes. The patient could not recall at any time having suffered from backache, lumbago, sciatica, or the like. The spine was freely moveable; there was no tenderness on pressure.

At examination on May 15, 1936, the patient complained of severe lumbago with bilateral sciatic radiation, and on April 12, 1937, she stated that she had been troubled by backache ever since the previous visit. Backward stretching, as when lifting an object from the floor, elicited pain in the back radiating down to the popliteal regions. The lumbosacral region was tender on pressure. The roentgenographic appearance of the

lumbosacral spine was identical with that found seventeen months previously.

CASE 2. A. S., male, fifty-three years of age, a merchant, was seen on June 6, 1937, complaining of dull pain in the right shoulder and weakness of the right arm. The right deltoid muscle was much thinner than the left. The grip of the right hand was weak (the patient was right-handed). There was an area of diminished sensitivity to touch on the lateral part of the right forearm.

Roentgenographic examination revealed narrowing of the fifth and sixth cervical intervertebral spaces and subluxation forward of the sixth and seventh superior articular processes; exostoses on these processes bulged into the right fifth and sixth intervertebral foramina. The cervical spine was freely movable, and there was no tenderness on pressure or percussion.

The patient stated that he had never suffered before from any kind of rheumatism; his wife, however, affirmed that "for at least twenty years past" the patient had very frequently complained of rheumatic pain in the shoulders, stiffness of the neck, and, more recently, of tingling sensations in the finger tips. This reminded the patient that he had consulted several physicians during the past ten years because of rheumatic pains, the nature of which, however, he was still unable to recall. (The patient is intelligent, calm, and highly spoken of as a very reliable person.)

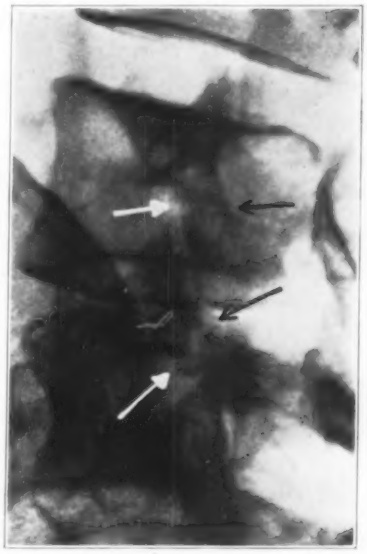

FIG. 24

Gaps in interarticular portion are visible. No displacement is present in the upper joint, but there is slight forward displacement (incipient spondylolisthesis) of the superior articular process of the lower vertebra, causing widening of the gap.

The patient was a female, twenty-four years of age, who complained of pain in the lower back.

CASE 3. A. J., female, forty-two years old, complained of pain in the right hand of eight years' duration and recently associated with weakness of the grip. Twenty years previously the neck had often been painful and "stiff". For the past three weeks pain in the left shoulder radiating to the finger tips had considerably impaired the use of the left arm and hand. There was no tenderness or rigidity of any section of the column. During the past five years, every imaginable mode of treatment had been attempted without relief. The spine had never been examined.

Roentgenographic examination on June 16, 1937, showed that the fourth and fifth cervical apophyseal joints were almost ankylosed. The discs were normal, but the ligaments were calcified.

These few examples out of many may serve to demonstrate the following points:

1. In the presence of definite anatomical changes, clinical symptoms may be temporarily absent, for the symptoms may develop a long time after anatomical changes have been accidentally discovered (Case 1).

2. The history is not reliable, "rheumatic" pains being subconsciously minimized (Case 2).

3. Clinical symptoms may fail to suggest a spinal lesion; consequently roentgenographic examination is often omitted (Case 3). Many cases thus escape statistical evaluation.

4. In spite of marked and persistent discomfort in the extremities,

there may be no symptoms and signs referred to the spine (Cases 2 and 3).

5. Generally speaking, the roentgenographic appearance of apophyseal lesions *in vivo* is clinically more significant than their aspect on autopsy. In anatomical investigations, the occurrence of narrowing of intervertebral foramina sufficiently marked to account for compression of nerves has been denied.[45] This is easily explained by the fact that, on autopsy, dehydration of nerves and decongestion of inflamed tissues, as well as the absence of postural influences that lead by displacement of bones to narrowing of foramina *in vivo*, make the interrelations appear different from those roentgenographically recognizable in the living patient examined in the upright position.

In this connection, however, it must be strongly emphasized that there neither is nor could possibly be a direct correlation between the degree and amount of the anatomical changes observed roentgenographically and the severity of the clinical symptoms. It is in the incipient stages that pronounced pain and disability are common, while the roentgenographic signs are not very marked. On the other hand, extensive bone changes are, in general, merely the result of a chronic process; and immobilization by exostoses and ankylosis may prevent further irritation of the joints.

DISCUSSION

For the recognition and comprehension of the diseases of the apophyseal articulations, it is necessary to consider them primarily and essentially as affections of true joints rather than as diseases of appendices of the vertebral bodies. That these joints are also parts of the spinal column is of secondary importance in this respect, for it has been the author's experience that the interrelations between the different types of spondylarthritis and the various forms of spondylitis and spondylosis are much less definite and constant than has been believed.

Roentgenologically, the two main types of arthritis reappear in affections of the apophyseal joints: atrophic spondylarthritis, marked by swelling of the capsule, rarefaction of bones, and, later, by destruction of cartilages; and hypertrophic spondylarthritis, in which hypertrophic bone changes are consequent upon lesions of the cartilage. As in all other localizations of arthritis, a combination of atrophic with hypertrophic changes may occur,—*e. g.*, in low-grade infections. Another form develops when, for reasons not yet known, the articular bone does not respond to the injury resulting from loss of cartilage. Secondary involvement of the joints in diseases of the adjacent bones may occur just as in other articulations, but it is very noteworthy that affections of the vertebral bodies, both localized and systemic, involve the articulations only rarely. The compact bones of the pedicles seem less liable to infection and rarefaction than the spongy vertebral bodies, and the compensatory expansion of the intervertebral discs (if they are not affected by the disease), as well as the

considerable resistance of the articular cartilages to mechanical stress, protects the articulations from injury. The following observations suggest that hypertrophic spondylarthritis develops chiefly in those patients in whom the cartilages are especially vulnerable:

1. There is a type of hypertrophic spondylarthritis in which the cartilaginous lesion cannot be accounted for by abnormal mechanical stress; in thirteen of the fourteen patients in this group, endamoeba histolytica was found in the stools, and relief was obtained by antiamoebic treatment. In the Near East, from 12 to 28 per cent. of the population are infected with amoebae, but the vast majority of these patients have no signs of hypertrophic arthritis.

2. Primary thinning of the intervertebral disc causes, by displacement of the superior articular process, very marked mechanical stress upon the facets. However, in only six out of 233 patients with thinning of the cervical discs and in forty-nine out of 204 patients with thinning of the lumbar discs were roentgenographic signs of hypertrophic arthritis found at this level.

Clinically, the infectious origin of atrophic spondylarthritis and of the type of hypertrophic spondylarthritis mentioned is suggested by the coexistence with various infections, and by the cure or arrest obtained by treatment of the underlying disease. As in other localizations, atrophic and hypertrophic arthritis in the apophyseal joints differ, as a rule, in the clinical course: atrophic spondylarthritis is marked by a more continuous chronicity, while hypertrophic spondylarthritis is usually associated with acute exacerbations alternating with periods at which the symptoms are very mild. Consequently, in hypertrophic spondylarthritis, one may find well-marked anatomical changes in patients who are free from discomfort during this examination, but, if one has an opportunity to reexamine these patients at intervals, symptoms of spondylarthritis will be observed almost invariably at some time or other. As in other joints, the inflammatory phase is marked by pain (spontaneous and on pressure) and by impaired mobility. Stiffness may be due to muscle tension, but rigidity independent of muscle spasms has been found to be invariably associated with narrowing of the apophyseal joint spaces indicative of thinning of the articular cartilage. This rigidity, unlike that caused by muscle tension, persists after the pain has subsided. Rigidity is not always caused by calcification of ligaments, or by the diminution of the distance between vertebral bodies that results from thinning of the discs, or by fusion of marginal vertebral exostoses. Even operative grafting of several vertebrae may have little influence upon the mobility of the spine.[8] On the other hand, thinning of the articular cartilages of one single apophyseal articulation may and does produce rodlike rigidity of a whole spinal section.

The observations leave little doubt that the integrity of the *articular cartilages* is essential to the normal mobility of the spine. This is substantiated by the fact that impaired mobility of the spine is found only in a

certain number of patients with radiating pain in the limbs that has been shown to be produced mainly by primary thinning of the discs (Badgley; Hodges and Peck; Oppenheimer; and Williams). In these patients, there may be no pain in the spine itself, in spite of radiculitis causing severe trophic disturbances.[46] In only sixty-one of the 437 patients with "discogenetic disease" did the author find pain (spontaneous or on pressure) and a certain amount of rigidity of the affected section. In forty-nine of these there was definite narrowing of the apophyseal joint spaces at the level of the collapsed intervertebral space, with or without hypertrophic changes of the articular processes.

On the other hand, radiculitis is by no means typical of discogenetic lesions; various diseases may, at least at certain stages, affect the intervertebral foramina.[32, 34] This occurs, for example, by constriction of their lumen during proliferative inflammation in acute spondylarthritis, or in isolated rarefaction of articular processes. However, the present observations reaffirm that pain in the spine itself usually precedes or accompanies radicular symptoms when the disease originates in the apophyseal joints.[34]

The classification of atrophic spondylarthritis is here given with some hesitation, but, because of the involvement of the synovial membranes and because of some demineralization in three of the cases, acute spondylarthritis is grouped with the atrophic type. This classification is now generally accepted, but it may well be that in the future an etiological classification will be possible, in which some types of both atrophic and hypertrophic arthritis are considered to be of infectious origin. Such a division into infectious and non-infectious arthritis has already proved its clinical value.[48]

SUMMARY

In answer to the four questions posed at the beginning of this paper, it seems justifiable to conclude as follows:

1. The two main types of arthritis affect also the apophyseal joints. *Atrophic* spondylarthritis, associated chiefly with focal or general infection, occurs in an acute reparable form in which the cartilages are not involved; in a localized chronic type, marked by destruction of cartilage; and as a chronic, more or less systemic disease, ankylopoietic spondylarthritis. *Hypertrophic* spondylarthritis, marked by destruction of cartilage, but not necessarily by bone hypertrophy, is often the result of persistent changes in the position of the vertebrae; in another type, independent of mechanical factors, it is possibly of infectious origin (amoebic?). *Secondary involvement* of the articular processes in inflammatory and rarefying diseases of the vertebral bodies is rare. *Isolated rarefaction* of the articular segments without cartilaginous lesions, another rare condition, is etiologically obscure.

2. Local pain (spontaneous and on pressure) and stiffness caused by muscle tension are found in active phases of any type of spondylarthritis.

Rigidity not caused by muscle spasms develops whenever articular cartilages are affected. Rigidity without pain is observed in quiescent hypertrophic and in arrested ankylopoietic spondylarthritis. In diseases of the vertebral bodies and intervertebral discs, local pain and persistent rigidity occur chiefly when the apophyseal articulations are involved. Radiculitis, which may develop in any disease that affects the intervertebral foramina, is not characteristic of particular lesions.

3. Atrophic spondylarthritis is independent of other systemic spinal diseases; there is especially no correlation either with spondylosis ossificans ligamentosa or with the various types of spondylitis. Hypertrophic spondylarthritis, being intimately related to postural alterations (mainly those resulting from "discogenetic" lesions), is often associated with traumatic changes,—hypertrophic spondylitis, scoliosis, and the like.

4. Acute atrophic spondylarthritis can be cured; chronic atrophic spondylarthritis can be arrested by successful treatment of the coexistent infection. In hypertrophic spondylarthritis, the treatment depends upon the underlying lesion (mechanical or infectious).

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AN OPERATION TO IMPROVE FUNCTION IN QUADRICEPS PARALYSIS *

BY CARL C. YOUNT, M.D., PITTSBURGH, PENNSYLVANIA

In 1926 the author read before the American Orthopaedic Association a paper on "The Rôle of Tensor Fasciae Femoris in Certain Deformities of the Lower Extremities". In this paper emphasis was placed on the following facts:

1. The so-called "hip-flexion contracture", seen so frequently in untreated cases of anterior poliomyelitis, in most instances is not a true flexion contracture, but an abduction contracture, the structures chiefly involved being the tensor fasciae femoris, the portion of the gluteus maximus which is inserted into the fascia lata, and the pseudotendinous prolongation of these two structures,—that is, the iliotibial band.

2. Because of the insertion of the iliotibial band into the tuberosity of the tibia, contraction results in external rotation of the tibia on the femur and is a factor in causing knee flexion, especially in those cases in which the quadriceps is weak or paralyzed.

3. The biceps is an important contributory factor in the pseudo knock-knee, knee flexion, and rotation of the tibia in the presence of a paralyzed quadriceps.

Cases were also reported in which the three deformities—hip flexion, knee flexion, and paralytic knock-knee—were successfully corrected by division of the iliotibial band and by the lengthening of the biceps tendon. One case was described in which the iliotibial band was transplanted to the patella to replace a paralyzed quadriceps. The following comments were made in regard to this case.

"In those cases in which the quadriceps is paralyzed and the tensors of the fascia lata are active the advisability of utilizing the latter as extensors of the knee suggests itself. Spitzy has devised and practised rather extensively an operation utilizing the tensor fasciae femoris muscle for this purpose. In his operation no consideration is given to the fact that a fair portion of the gluteus maximus functions as a tensor of the fascia lata and acts conjointly with the tensor fasciae femoris muscle by means of its fusion with the latter in the ilio-tibial band. With this in view the operation has been modified to the extent that instead of stripping free a narrow portion of the fascia lata, up to the muscular insertion of the tensor fasciae muscle, a broad fan-shaped section of the fascia lata is included, the broad part being taken from the lateral and posterior surface, the dissection extending up to the lower edge of that portion of the gluteus maximus which is inserted into the fascia lata. . . . If that portion of the gluteus maximus which acts as a tensor can thus

* Read at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 10, 1933.

be successfully utilized as an extensor there would seem to be little doubt regarding the value of this procedure.

"In those cases in which both groups of hamstring muscles are acting, the transference of the biceps with the tensors as described would probably give the best obtainable results from tenolysis for paralysis of the quadriceps."

Since 1926, sixteen cases of quadriceps paralysis, in all of which knee-flexion and hip-flexion contractures were present, have been treated by operative transference of the iliotibial band. In eight of these cases the biceps muscle was also transplanted in conjunction with the iliotibial band. In earlier cases the iliotibial band was merely freed and sutured to the patella, and the biceps was transferred according to the methods previously described by Crego and Fischer.

It seemed to the author that more radical dissection was necessary to utilize effectively the abundant muscle power available in that part of the gluteus maximus which is inserted into the fascia lata. It also seemed that the biceps muscle had not been sufficiently mobilized to place it in the position of strongest mechanical advantage for its new function. For these reasons the operative technique was gradually modified extensively. Those of us who have observed these cases under the original technique and later with the modified method feel thoroughly convinced that the more radical procedure is amply justified by the improvement in function.

OPERATIVE TECHNIQUE

A long incision is made, beginning just below the greater trochanter and extending from the lateral aspect toward the middle of the dorsal surface of the thigh to the patella, and across the patella down through the tuberosity of the tibia. The edges of the skin are then reflected on each side by blunt dissection, fully exposing the fascia lata from the middle of the thigh to the inferior edge of the lateral surface. It is important that the reflection of the skin should be sufficiently wide to expose the insertion of the gluteus maximus into the fascia lata. The biceps tendon is next isolated just above the head of the fibula and, after two-thirds of this tendon has been stripped free from the head of the fibula, it is dissected upward until the muscle fibers of the short head begin to show. The dissection of the long head of the biceps only is then continued upward, either bluntly with gauze or by actually cutting it free from the short head. The long head of the biceps should be freed from surrounding structures sufficiently high to enable its course to be changed, so that it will enter the tunnel which is later made for the two tendons at an advantageous angle. There is a distinct line of separation between the short head and the long head, and it is possible to separate them easily. There is no advantage in trying to utilize the short head of the biceps, as it cannot be mobilized adequately without too much trauma, bleeding, and destruction of its own nerve supply; moreover,

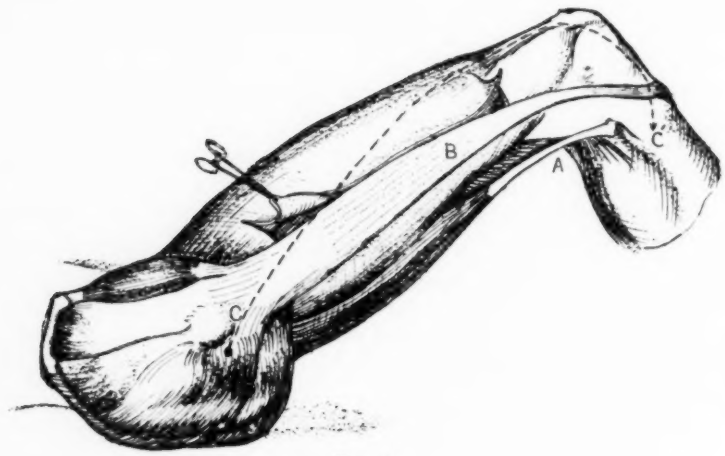

FIG. 1

Method of constructing tube: *A*, biceps; *B*, fascia lata and iliotibial band; *CC'*, line of skin incision.

if it is retained as a flexor of the knee, it is unquestionably valuable in preventing the development of genu recurvatum, which of course is a possibility in these cases, especially if the other hamstring muscles are weak. The insertion of the iliotibial band is next freed subperiosteally from the tuberosity of the tibia. A strip about half an inch in width is dissected free, extending from the tuberosity laterally across the surface of the knee joint up to the part of the iliotibial band which is well defined. Beginning about two inches above the knee joint, the strip of the fascia lata which includes the iliotibial band is widened gradually toward the

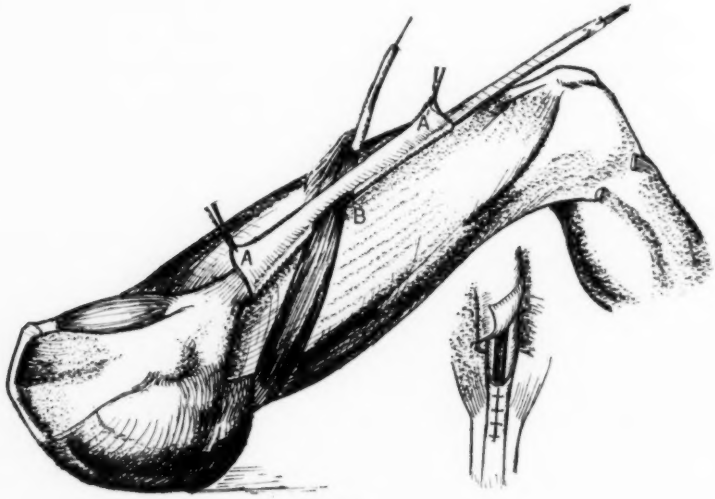

FIG. 2

The fascial transplant traverses the tube made by folding the fascia lata *A* to *A'*. The biceps enters the tunnel at *B*.

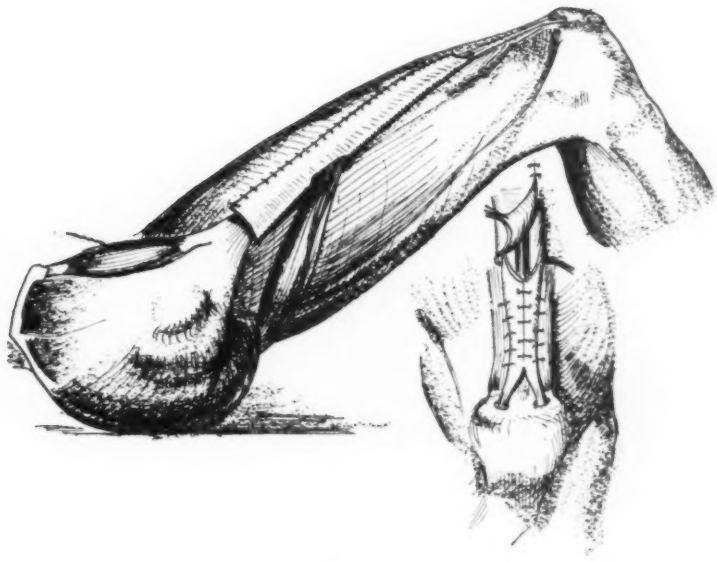

FIG. 3

upper third of the thigh. Where it approaches the insertion of the gluteus maximus it is widened out considerably and stripped free up to the point where the fibers of the gluteus maximus insert into it. The mesial edge of the section of the fascia is stripped up, so that it includes the tensor fasciae femoris.

Having freed the structures which are chiefly responsible for the contracture, it is found quite easy to correct the flexion and the rotation deformity at the hip and knee by manual force. It is advisable, however, to use a moderate amount of force and not to attempt to overcome fully the contractures at this time. In the most extreme cases in the author's series, not more than 20 degrees of hip flexion and 15 degrees of knee flexion have been present after the forced manipulation described. The final correction of these deformities should be deferred until after complete healing has taken place.

In the earlier cases it was found that the transposed structures remained too far out on the lateral surface of the thigh to give the maximum function. In order to transpose them to a position which would more nearly approximate that of the quadriceps, a tube, constructed from the inner lip of the cut fascia lata, is made by folding it upon itself toward the mesial aspect of the limb (Fig. 1). In the upper part of the thigh the tube should be so placed that it will lie laterally and then gradually extend obliquely toward the middle as it approaches a point about three inches above the patella. The transplant of tensor fasciae latae enters the tube at its top, but it is necessary to make a separate opening in the tube approximately two inches below the top for the biceps (Fig. 2). After emergence from the tunnel, the biceps is stitched to the fascial

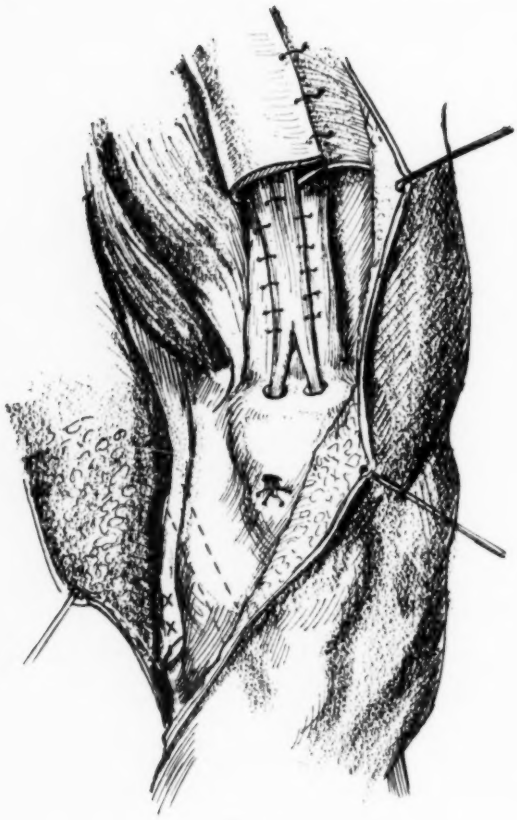

FIG. 4

Showing the plastic suturing completed.

transplant, as it will be found in most cases that the biceps will not reach the patella. Both these structures are then sutured to the quadriceps tendon, after the latter has been incised in the mid-line one and one-half inches above the patella. The fascial transplant is divided into two parts at the end, and is imbedded in two holes (punched or drilled) in the patella. (See Figures 3 and 4.)

After the usual closure of the wound, a cast, extending from the perineum to the toes, is applied. Moderate force only should be used in correcting knee flexion. In applying the cast the correction of knee rotation should not be overlooked. A strict Soutter position is not used immediately after the operation, but gradual correction of the hip flexion is accomplished by elevating the buttock by means of boards and pillows under the mattress.

POSTOPERATIVE CARE

In cases with marked hip-flexion contracture, correction is deferred until approximately four weeks after operation, when the patient is placed in the strict Soutter position. Additional correction of the knee flexion is accomplished after the four weeks' period by means of a wedged cast.

At the end of the fifth week after the operation, massage and muscle reeducation are begun. In most cases old braces which these patients have been wearing are refitted and worn usually only for six or eight weeks. Most of the author's patients have been able to walk without braces so soon after the operation that he has not felt it justifiable to order braces. The only advantage of the brace is that if it is worn the patient can be discharged from the hospital more quickly.

COMMENT

This operation, of course, has been developed as a type of procedure to be used in a particular group of cases in which a fairly uniform type of deformity and similar residual power in the extremity are present. For that reason no attempt will be made to contrast it with other types of operations in which other muscles are utilized. It is the author's belief that there is no best operative procedure for the replacement of the paralyzed quadriceps, but each case presents its own problem and the type of operation to be chosen will depend upon the available muscle power for transference.

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"SPONDYLODESIS"

The Use of the Short Bone Graft in Fusion of the Tuberculous Spine

BY J. DE MOL VAN OTTERLOO, M.D., 'S-GRAVENHAGE, NETHERLANDS

From the Queen Sophia Memorial Children's Hospital

Tuberculosis of the spine is a condition which may give rise to difficulties in treatment, not only from the general pathological, but also from the orthopaedic point of view. It is the author's purpose to discuss the causes of these difficulties and to advocate a method of treatment which has been found to improve the end results in many cases.

The spinal tuberculosis of children should be considered separately from that of adults, because, as a rule, the course is different.

In children spondylitis often leads to bony union of the involved vertebrae, while in adults the bony remnants of the vertebrae do not grow into one bone block and a pseudarthrosis remains as a result of the healing. Also, in the process of healing, the thoracic vertebrae behave differently from the lumbar vertebrae, due to the difference in anatomical structure. (See Figure 1.) When destruction of the body occurs in the thoracic spine, the upper thoracic vertebra tips forward, being caught on the superior articular processes of the thoracic vertebra below; whereas, in the lumbar spine, the upper lumbar vertebra may sink down more perpendicularly upon the lower vertebra, because the surfaces of the lumbar intervertebral articulations are able to slide vertically along each other, as they are placed in the sagittal plane. Consequently, in the lumbar column, there is a firmer contact between the fragments of the involved vertebrae, as the centra are vertical.

FIG. 1

Showing the tenth, eleventh, and twelfth thoracic vertebrae and the first and second lumbar vertebrae. In the twelfth thoracic vertebra the upper articulations are in the frontal plane, while the lower articulations have turned about 90 degrees and are placed in the sagittal plane.

In children a spondylitis of two or three lumbar vertebrae usually leads to bony union with or without minimal kyphosis; whereas in cases of involvement of the thoracic vertebrae frequently bony union does not occur and a kyphosis is unavoidable. In adults, however, neither thoracic nor lumbar spondylitis results in bony union, and a pseudarthrosis persists.

It should not be forgotten that, in the

course of the disease, bony union of the small intervertebral joints may occur, although one often finds, in studying specimens of a tuberculous spondylitis, non-union of both vertebral bodies and intervertebral joints.

As a matter of fact, in many cases in children, even after a long conservative treatment, there results a non-union,—a pseudarthrosis of the involved part of the vertebral column. The motion and flexibility of this pseudarthrosis may be considerable. Roentgenographic examination in such cases may give an idea of this condition.

To determine this pseudarthrosis, the examination is carried out as follows: The exposure is made with the patient in the lateral position and the spine in hyperflexion; then a second lateral exposure is made with the spine in hyperextension. When these roentgenograms are compared, the angle of inflexion—at the kyphos—will show in many cases a change of 20 degrees or more. This motion is in a most vulnerable place—a weakened area of the spine—which is continuously exposed to distortion, bleeding, and oedema, and eventually may be complicated by neurological symptoms. No doubt, many cases of recurrence of the tuberculous disease, as well as of back symptoms, are due to a more or less loose pseudarthrosis. To date, roentgenographic examination of all patients seen by the author because of recurrence of symptoms showed a lack of bone-block formation.

This condition may be compared with any pseudarthrosis resulting from tuberculosis,—for example, that of the hip. As the extrafocal fusion of a pseudarthrosis of the hip is considered to be the best treatment, it seems advisable to base the treatment of a like condition in the spine on the same principle,—namely, an extrafocal fusion of the involved vertebrae.

Jacques Calvé, of Berck, France, was the first to advocate the use of a short bone graft which fuses only the affected vertebrae, and the author believes that this is the correct procedure. If, after consistent conservative treatment, the bony fragments of the involved centra do not grow into one bone block, and a pseudarthrosis persists, a fusion of these vertebrae

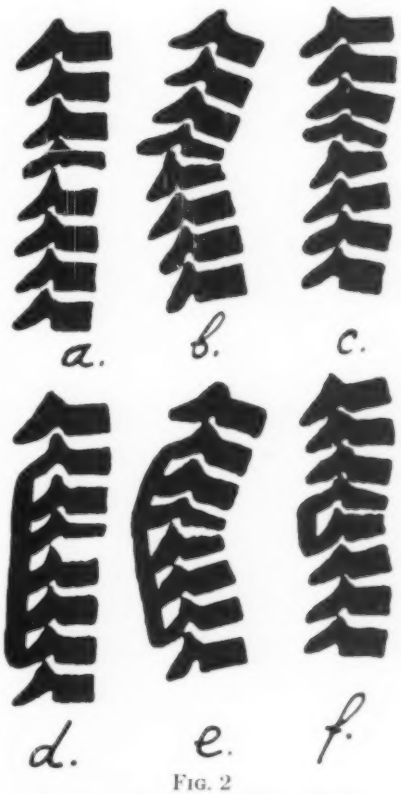

FIG. 2

Showing the natural physiopathological course of a case of tuberculosis of the spine (*a*, *b*, and *c*) with the formation of a compensatory lordosis (*c*). The long bone graft impedes both the collapse (*d*) and the formation of a lordosis (*e*). The spondylodesis (*f*) fuses only the involved vertebrae. (*Courtesy of Nederlandsch Tijdschrift voor Geneeskunde.*)

should be done. The author proposes calling this operation "spondylodesis", because of the analogy to arthrodesis for the fusion of a joint.

In the writer's opinion, the long bone graft, extending from two vertebrae above to two vertebrae below the focus, is based on a false principle. Since the long bone graft fixes together a number of vertebrae, it interferes with the natural correction of the parafocal spine,—the forming of a compensatory lordosis (Fig. 2,*c*). Furthermore, this fusion, which is usually done in the early stage of the disease, is objectionable for the following reasons: It cannot arrest the extension of the tuberculous disease, and it interferes with the process of repair, since it impedes the natural physiopathological collapse and the elimination of space between the destroyed vertebrae. Also, is not the contraction of the fibrous tissue, which results from tuberculous granulation, a *conditio sine qua non* for a thorough repair of any tuberculous focus?

FIG. 3

The use of the long bone graft is supposed to be advantageous, because it protects against the intrafocal pressure caused by the weight of the upper vertebral column, but pressure should not be feared during the stage of repair in which the spondylodesis is preferably done. It is even desirable as a functional stimulus to bone formation!

With the long bone graft, it is more possible to avoid motion between the involved vertebrae

FIG. 4

FIG. 5

Fig. 3 and Fig. 4: Patient with tuberculosis of the second, third, and fourth lumbar vertebrae, in whom total fusion of the lumbar spine by a long bone graft had been performed.

Fig. 5: Same patient as shown in Figs. 3 and 4, after removal of the superfluous portion of the graft.

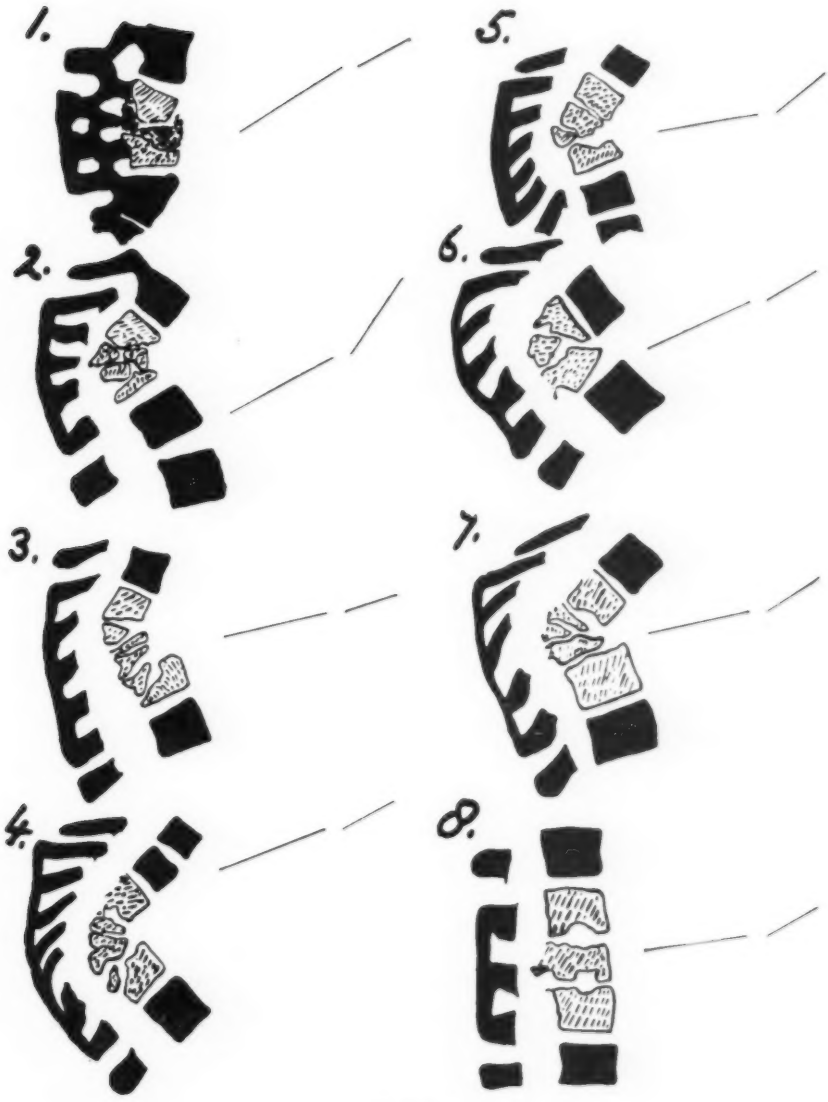

FIG. 6

Schematic drawings of the spines of eight children. The curve beside each sketch shows the increase in body weight a year before the operation and after the operation. (*Courtesy of Nederlandsch Tijaschrift voor Geneeskunde.*)

than with the short bone graft, but motion of the vertebrae, grown to one functional unit after the spondylodesis, should not be considered as harmful, for the movements take place in the normal intervertebral discs and joints above and below this unit.

Figures 3 and 4 show a boy suffering from tuberculosis of the second, third, and fourth lumbar vertebrae. On admittance to the Hospital, the back was quite rigid and did not permit the patient to lean forward very

much, because of the total fusion of the lumbar spine by a long bone graft. Figure 5 shows the same boy after the superfluous part of the long graft had been removed.

The short bone graft is based on a different principle; it is employed as a final procedure of conservative treatment.

Every case of tuberculosis of the spine, in children as well as in adults, should be treated conservatively at first. The usual general treatment should be combined with absolute recumbency in a plaster bed for several years. The final spondylodesis, which is done in certain cases, is only to be considered as a safety-lock to reenforce a healed condition. After the operation, the patient remains in a plaster bed for about six months and is gradually mobilized in a light, reenforced, celluloid jacket. As a matter of fact, the spondylodesis not only influences the local part of the spine, but it even improves the general condition.

Figure 6 shows the spines of the first eight children operated upon by the author. The curve beside each of the schematic drawings shows the increase in body weight a year before the operation and a year after the operation; the initial drop following the operative procedure is not recorded. With the exception of the first and third cases, there is a remarkably rapid increase in weight after the operation.

These absolutely objective observations are very important, and the early results of the operation warrant its further use.

ENLARGEMENT OF THE LIGAMENTUM FLAVUM

A Cause of Low-Back Pain with Sciatic Radiation *

BY HOWARD A. BROWN, M.D., SAN FRANCISCO, CALIFORNIA

From the Department of Surgery, University of California Medical School

Enlargement of the ligamentum flavum producing compression of nerve roots is a more common cause of low-back pain with sciatic radiation than has been recognized. During the past seven months, seven patients with such symptoms have been proved at operation to have enlargement of the ligamentum flavum. Relief followed operation.

Few reports of this condition have appeared in the literature and little attention has been accorded them. The earliest report which the writer has been able to find is that by Elsberg in 1913. This was a typical case of compression of the nerve root following trauma. An enlargement of the ligamentum flavum was found at operation and complete relief of symptoms followed its removal. In 1916, the same author mentioned briefly two cases of enlarged ligamentum flavum. In 1931, Towne and Reichert reported two cases without antecedent trauma. An article by Puusepp appeared in the Esthonian literature in 1932, reporting three cases, in two of which trauma might have been a factor. In 1936, Abbott reported one traumatic case with recovery after operation. In the same year, Hampton and Robinson mentioned a case in an article on the roentgenographic findings in rupture of the intervertebral disc. Spurling, Mayfield, and Rogers have recently reported seven similar cases with relief of symptoms following operation.

During the past few years we have learned that rupture and dislocation of a portion of an intervertebral disc is a rather common cause of low-back pain with sciatic radiation. The history and symptoms of patients with enlarged ligamenta flava are essentially the same, and clinical differentiation between these two conditions is extremely difficult or impossible. In many instances, too, these syndromes cannot be differentiated clinically from lumbosacral or sacro-iliac disorders, and careful study is required before a diagnosis can be reached.

A history of trauma, usually of relatively slight degree, is common. This was true in six of our seven patients. The most frequent history of injury was of lifting, in association with flexion and torsion of the spine, or a fall on the buttocks. The patient usually described a snapping sensation in the spine followed by pain low in the back and, later, gradual radiation of the pain over the sciatic distribution into the thigh, the leg, and the foot. The interval between the onset of pain in the back and radiation into the leg varied from a few hours to several months. The

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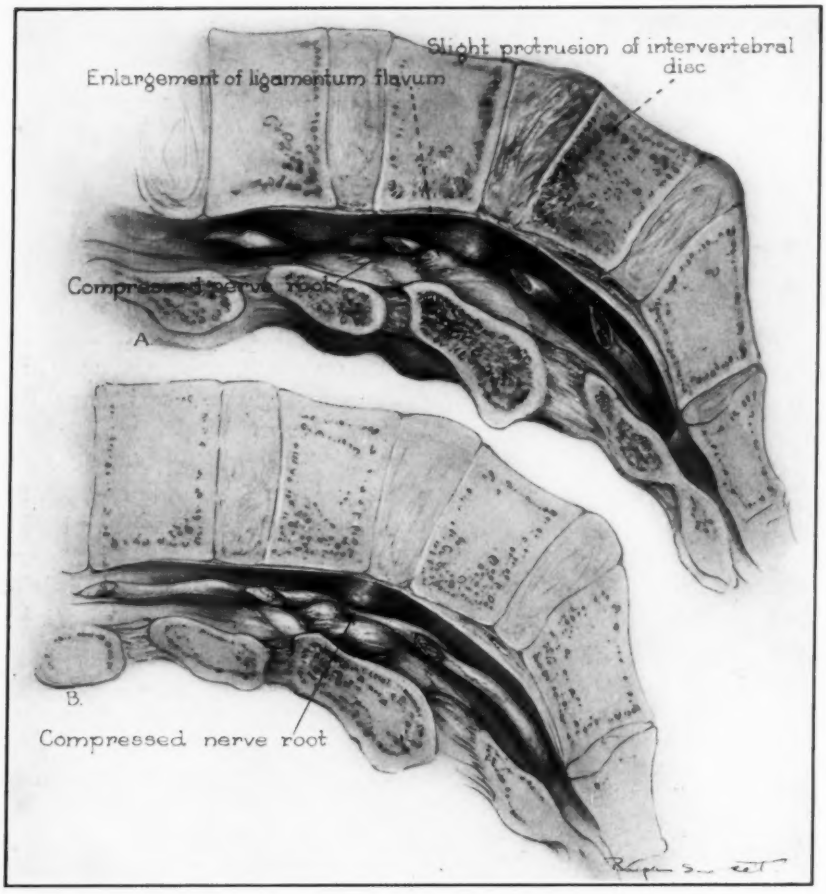

FIG. 1

Sagittal section of the lumbosacral spine. This drawing was made from a specimen with an enlarged ligamentum flavum to show the mechanism of compression of the nerve root. The dura has been removed.

A: Lateral view.

B: The specimen has been rotated to demonstrate the point of compression of the nerve root.

pain was usually severe and often disabling. In patients with enlargement of the ligamentum flavum, sensory disturbances—numbness and paraesthesia—may be present, and there is likely to be some degree of motor weakness in the involved extremity. In a small percentage the sphincters may be affected. The symptoms are usually unilateral, but may be bilateral if the encroachment on the spinal canal is of sufficient extent. Weight-bearing almost always aggravates the symptoms, and rest in a recumbent position may afford some degree of relief.

Objectively, the most common findings in our patients were some degree of scoliosis with a list to the unaffected side, a general restriction of movements of the back, and limitation of straight-leg raising on the involved side. Local tenderness over the lumbar spine was present, but

was seldom severe. Some motor weakness was usually found, most often in the anterior tibial muscles. The most constant single finding was a decrease in the Achilles-tendon reflex on the side of the lesion. Sensory disturbances of varying degree were present over the buttocks, the posterior aspect of the thigh, the calf, and the foot. The most common sensory alteration appeared over the outer aspect of the lower part of the leg and the dorsum of the foot.

Plain roentgenograms of the spine showed no pathological change in the bones or the joints and were of little value.

A positive diagnosis of enlargement of the ligamentum flavum can seldom be made from a clinical study alone. Spinal puncture and the use of lipiodol are required. An increase in the total protein content of the spinal fluid above fifty milligrams per 100 cubic centimeters, suggestive of an intraspinal pathological process, was present in three of the four cases in which this determination was made. The Wassermann reactions were negative in all seven cases. At least four cubic centimeters of lipiodol should be used in order to locate a minor defect in the spinal canal. Roentgenographic examination should be made with the patient in the prone position and any defects should be checked by immediate films, without moving the patient. In the absence of abnormalities, the examination should be repeated after an interval of two weeks, to be certain that a defect has not been overlooked.

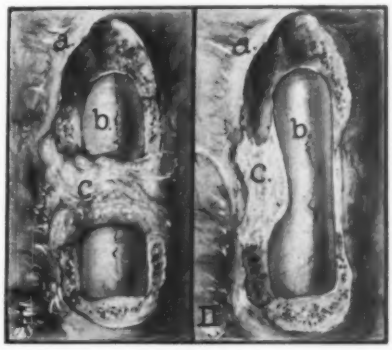

FIG. 2

Drawing made at operation after removal of the lamina.

I: View before removal of the ligamentum flavum: *a*, laminal margin; *b*, dural sac; *c*, enlarged ligamentum flavum intact.

II: View after removal of the dorsal portion of the ligament: *a*, laminal margin; *b*, dural sac; *c*, unilateral enlargement of the ligamentum flavum.

The enlargement of the ligaments occurred between the fourth and fifth lumbar vertebrae in six of our patients and at the lumbosacral junction in one.

Study of the anatomy of the ligamenta flava shows that even a moderate enlargement may cause compression of the nerve roots. These ligaments arise from the dorsal and upper margins of each lamina, pass upward beneath the lamina immediately above, and enter the neural canal. They fuse in the mid-line and laterally have expansions which extend well down toward the anterolateral aspects of the neural canal and form the posterior margins of the intervertebral foramina. The ligaments lie in close association with the articular facets in the neural canal and, to some degree, form a capsular covering for the articulations. Directly below each ligament lies the intervertebral disc, and the very narrow space between them serves as a passage for the nerve root after it

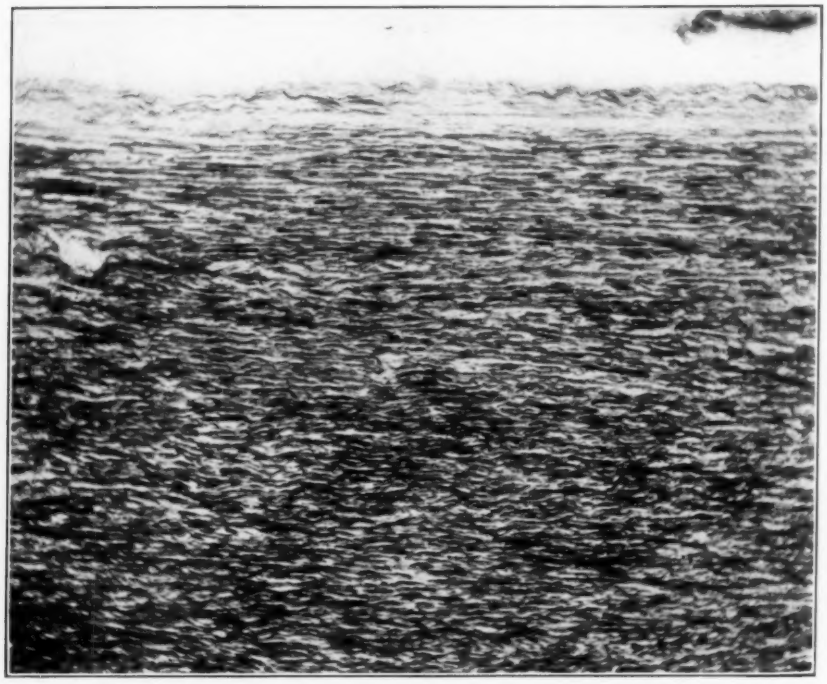

FIG. 3

Photomicrograph of normal ligamentum flavum.

emerges from the dural canal. An increase in the size of the ligament, a posterior protrusion of the disc, or a combination of the two, serves to compress the nerve root at this point (Fig. 1). Enlargement of the ligament may be generalized, although sometimes it is unilateral (Fig. 2), and it probably results from two factors,—namely, injury and scar tissue. Normal ligaments are composed entirely of yellow elastic fibers (Fig. 3) and grossly have considerable elasticity. Even at necropsy, however, we have observed a bulbous expansion of the ends of the ligaments when they have been torn during removal. It seems likely that at the time of the injury—whether minor or severe—rupture of some of the elastic fibers of the ligamenta flava occurs, allowing them some degree of expansion. Subsequently, as repair takes place, scar tissue is formed with further enlargement of the ligaments, so that compression of the nerve roots may result. Such injury and replacement by scar tissue can be demonstrated microscopically after the surgical removal of the enlarged ligament (Fig. 4). Sections should be made a short distance from the points of attachment to the bone, so that normal fibrous tissue at these points will not be mistaken for scar tissue in the ligament.

Treatment consists of laminectomy and a wide lateral removal of the enlarged ligament in order to free the nerve root from compression. As the lamina is removed, the ligament is seen immediately beneath it and,

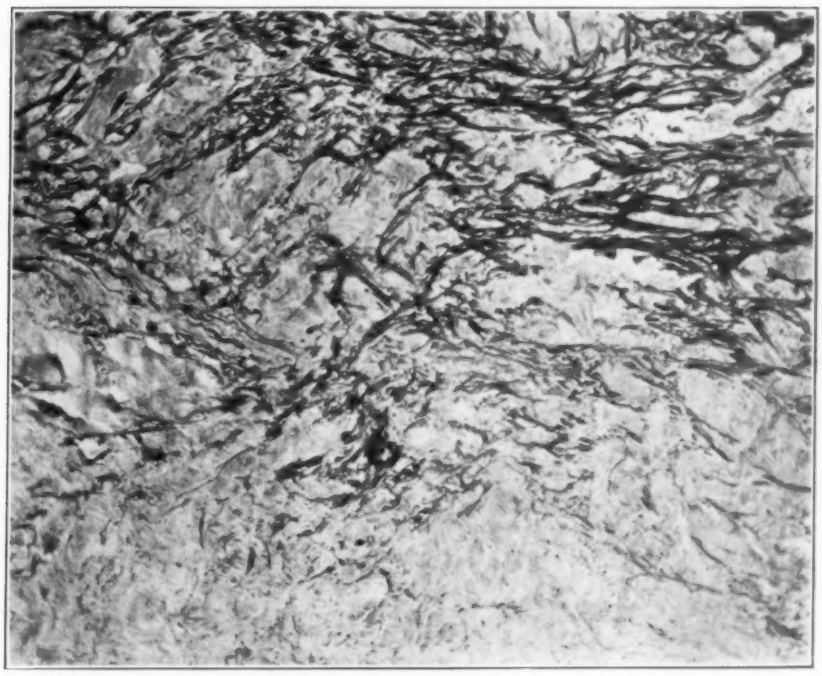

FIG. 4

Case 1. W. F. L. Photomicrograph demonstrating the typical fibrotic scarring and marked degeneration and derangement of the yellow elastic fibers.

if the enlargement is generalized, the constriction of the dural sac is often striking. Normally the ligaments in the lumbar region are from two to three millimeters in thickness, but, in the more marked enlargements, they have measured as much as one centimeter. The majority are not adherent to the dura, but in one instance (Case 7) the ligament was firmly bound down to it. No changes were noted in the laminae overlying the enlarged ligaments. In all cases a careful search was made to determine the possible presence of a ruptured intervertebral disc. In two cases, a very small prominence of the disc was found in association with the enlarged ligamentum flavum. These did not amount to real dislocations of the intervertebral disc and, alone, would not have been sufficient to produce compression of the nerve roots. Any undue prominence of the disc, however, serves to decrease the size of the passage for the nerve root (Fig. 1), so that even a moderate enlargement of the ligament would compress the root against it.

Ordinarily the laminae are removed by rongeurs and the ligamenta flava are often removed with the bone. Consequently it would be possible to overlook an enlargement of the ligament and feel that no lesion had been present. It is likely that such a removal of an enlarged ligamentum flavum explains certain cases in the past in which definite defects had been shown by the injection of lipiodol, but nothing was found at

operation to explain them. Nevertheless the symptoms were relieved after operation because of the decompressive effect of the laminectomy and of the simultaneous removal of an unsuspected enlarged ligamentum flavum.

In most of our patients rapid relief of pain followed removal of the ligament. If the compression of the nerve root had been prolonged and severe, recovery from the alterations in sensation, motor power, and reflexes was gradual, as is the case in the recovery and regeneration of any peripheral nerve following trauma.

REPORT OF CASES

Case 1. A fall on the buttocks was followed by low-back pain with unilateral sciatic radiation of seven months' duration. The spinal fluid showed an increased protein content and roentgenographic examination demonstrated a defect in the column of lipiodol at the lumbosacral junction. Removal of an enlarged ligamentum flavum gave relief of symptoms.

W. F. L., male, twenty-six years of age, was seen first in September 1936. On July 26, 1936, the patient had slipped, landing with considerable force on the buttocks. There was no immediate complaint, but on the following day he noted an aching pain in the right buttock, with slight discomfort down the posterior aspect of the thigh. There was a gradual increase in the severity of the pain and it was aggravated by activity. Rest in a recumbent position afforded complete relief of symptoms. The patient was treated by heat, massage, and supportive measures, without improvement in the symptoms.

Examination was made on September 5, 1936. There was great limitation of forward bending, restriction of straight-leg raising on the right side to 45 degrees, and moderate tenderness of the sciatic nerve at the sacrosciatic notch. No muscle atrophy was present. The right Achilles-tendon reflex was decreased and some hypaesthesia was present over the posterior portion of the thigh and the posterolateral aspect of the lower extremity. Roentgenograms of the lumbosacral spine were negative. An injection of the sacral hiatus with normal salt solution gave temporary relief, but the symptoms gradually recurred with persistence of the same findings. In January 1937, spinal puncture was done; the hydrodynamics of the spinal fluid were normal; the total protein content was ninety-seven milligrams per 100 cubic centimeters. Injection with lipiodol and fluoroscopic studies demonstrated a constriction in the dural sac at the lumbosacral junction (Fig. 5). This was interpreted as representing a dislocation of an intervertebral disc.

Laminectomy was performed on February 17, 1937, and an enlarged ligamentum flavum was found constricting the dural sac at the lumbosacral junction. It was removed widely on both sides. Careful exploration showed no other pathological process. Great scarring of the ligament, with destruction and fragmentation of the elastic tissue, was shown by microscopic examination. The patient was immediately relieved of pain by the operation. His only residual complaint was an occasional slight sensation of numbness in the left leg upon undue activity. Motor power, sensation, and reflexes rapidly returned to normal.

Case 2. Low-back pain with unilateral sciatic radiation for thirteen months followed an indefinite injury to the back. Examination with lipiodol was only suggestive of a defect between the fourth and fifth lumbar vertebrae. Removal of an enlarged ligamentum flavum (unilateral) was followed by improvement.

N. H., male, twenty-eight years of age, a bookkeeper, entered the hospital on August 24, 1936, complaining of pain low in the back on the left side, with typical sciatic radiation into the left lower extremity. The patient had first noticed pain in the back six months prior to entry, particularly after long automobile drives. Three months later, after spading, the pain had radiated down the posterior aspect of the left lower extremity, extending into the calf and the ankle. Following this, flexion or rotation of the spine aggravated the pain. The left leg tired easily. Very little relief was obtained by rest in bed. The only history of injury in this case was of an automobile accident a year before entry, but no definite injury to the patient's back was noted at the time.

There was marked bilateral limitation of straight-leg raising; the left gluteal muscles were somewhat flabby; the power of the left leg was approximately equal to that of the right. The left patellar-tendon and Achilles-tendon reflexes were less active than the right. No sensory disturbance was noted. Jugular compression produced pain in the left leg. Roentgenographic examination showed six lumbar vertebrae with sacralization of the last segment. Spinal puncture caused an unusual amount of pain when the needle compressed the dura; the hydrodynamics of the spinal fluid were normal. Lipiodol was injected, but fluoroscopic studies were negative.

The patient was treated by manipulation and traction, without relief. Six weeks later, the fluoroscopic studies were repeated and were suggestive of a defect at the level between the fourth and fifth lumbar vertebrae on the left. In view of the persistent symptoms, the positive neurological findings, and the failure to obtain relief by conservative measures, laminectomy was decided on and was done on March 10, 1937. A moderate enlargement of the ligamentum flavum was found on the left side between the fourth and fifth lumbar vertebrae. Careful search of the canal showed no evidence of a ruptured intervertebral disc. On microscopic examination of the enlarged ligament, damage to the elastic tissue and replacement by scar were found, as shown in Figure 4. The patient had much less pain after operation, although he was not entirely relieved

FIG. 5

Case 1. W. F. L. The use of lipiodol demonstrates a defect at the lumbosacral junction.

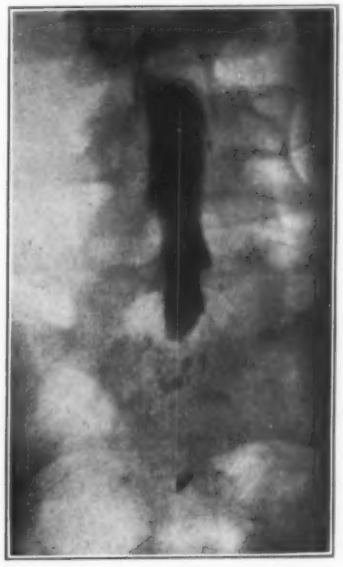

FIG. 6

Case 3. J. G. There is a slight defect in the column of lipiodol between the fourth and fifth lumbar vertebrae on the left.

of it. He returned to work about six weeks after operation and has continued to perform his regular duties. Straight-leg raising has greatly improved and, at the present time, there is no evidence of motor, reflex, or sensory change. The residual discomfort in this case may be explained by a failure to remove the ligament sufficiently far laterally to decompress the nerve root completely near the intervertebral foramen.

Case 3. Low-back pain with unilateral sciatic radiation of five months' duration occurred after torsion of the spine. The protein content of the spinal fluid was increased and lipiodol showed a unilateral defect between the fourth and fifth lumbar vertebrae. An enlarged ligamentum flavum (unilateral) was removed and a prominent intervertebral disc was found behind the nerve root. Complete relief of signs and symptoms followed operation.

J. G., male, twenty-four years of age, entered the hospital in March 1937. In October 1936, the patient had leaned inside an automobile to wipe a windshield. He noted a snapping sensation in the lower part of the back and complained of pain low in the back immediately thereafter. Five days later the pain radiated over the sciatic distribution into the left lower extremity. When the patient was recumbent, the pain subsided, but it recurred immediately on weight-bearing. He had noted no numbness or motor weakness.

Examination on January 13, 1937, showed no spasm of the muscles low in the back, although there was tenderness between the fourth and fifth lumbar vertebrae. Jarring, at this point, produced some degree of pain in the left leg. No muscle atrophy was present, but there was slight weakness of the left extensor hallucis longus. Sensation was normal; the left Achilles-tendon reflex was decreased. Roentgenographic examination of the lumbosacral region was negative. Spinal puncture was done, showing normal hydrodynamics of the spinal fluid; the total protein was fifty-seven milligrams per 100 cubic centimeters. Lipiodol studies under the fluoroscope demonstrated a very slight defect between the fourth and fifth lumbar vertebrae on the left side (Fig. 6). The defect was so slight that further conservative measures were tried. Traction gave temporary improvement, but weight-bearing immediately brought on pain low in the back and in the leg.

Laminectomy was performed on March 15, 1937. The ligamentum flavum on the left side was enlarged and the increase in size was most evident in the lateral portion adjacent to the fifth lumbar root. Following the removal of the enlarged ligament, inspection behind the root showed a very slight prominence of the intervertebral disc at that point. This prominence, in itself, would not have produced symptoms, but the combination of the enlarged ligament and the prominence of the disc undoubtedly did cause them. The patient's pain was immediately relieved, and the reflexes gradually returned to normal. He went back to his regular work about two months after operation and has had no recurrence of pain.

Case 4. A fall on the buttocks preceded low-back pain with unilateral sciatic radiation of fourteen months' duration. Lipiodol demonstrated a generalized constriction of the dural sac. An enlarged ligament was removed, with relief of pain and gradual improvement in the motor and sensory loss.

T. O'C., male, fifty-five years of age, was injured on February 29, 1936, when his left foot slipped into a pit and he dropped sharply to the ground, striking the buttocks. He had immediate pain low in the back, which persisted in spite of constant treatment. It was not until August 1936 that he first began to have radiation of pain over the distribution of the left sciatic nerve, extending to the ankle. A manipulation at this time resulted in temporary improvement. Later, an injection of the sacral

hiatus with novocain seemed to aggravate the pain. Numbness appeared over the outer aspect of the lower part of the left leg and the patient began to notice weakness of the anterior tibial muscles.

Examination was done on March 12, 1937. There was no tenderness in the lower part of the back. Forward bending was markedly restricted and straight-leg raising on the left was limited to 25 degrees; no atrophy was present; power in the anterior tibial muscles was considerably lessened. There was a decrease in sensation along the lateral side of the leg and the dorsum of the foot. The left Achilles-tendon reflex was absent. Roentgenograms of the lumbosacral region showed no signs of trauma. The hydrodynamics of the spinal fluid were normal. Lipiodol demonstrated a very marked constriction of the meningeal sac between the fourth and fifth lumbar vertebrae (Fig. 7). An enlarged ligamentum flavum was suspected before operation in this case.

Laminectomy was done on April 15, 1937, and an unusually large ligament was found, producing a uniform constriction of the dural sac and its contents on both sides. An extensive removal was done, care being taken that the lateralmost part of the ligament was removed. The fifth lumbar root on the left was swollen. No evidence of a ruptured intervertebral disc was found. A spinal fusion was done following laminectomy.

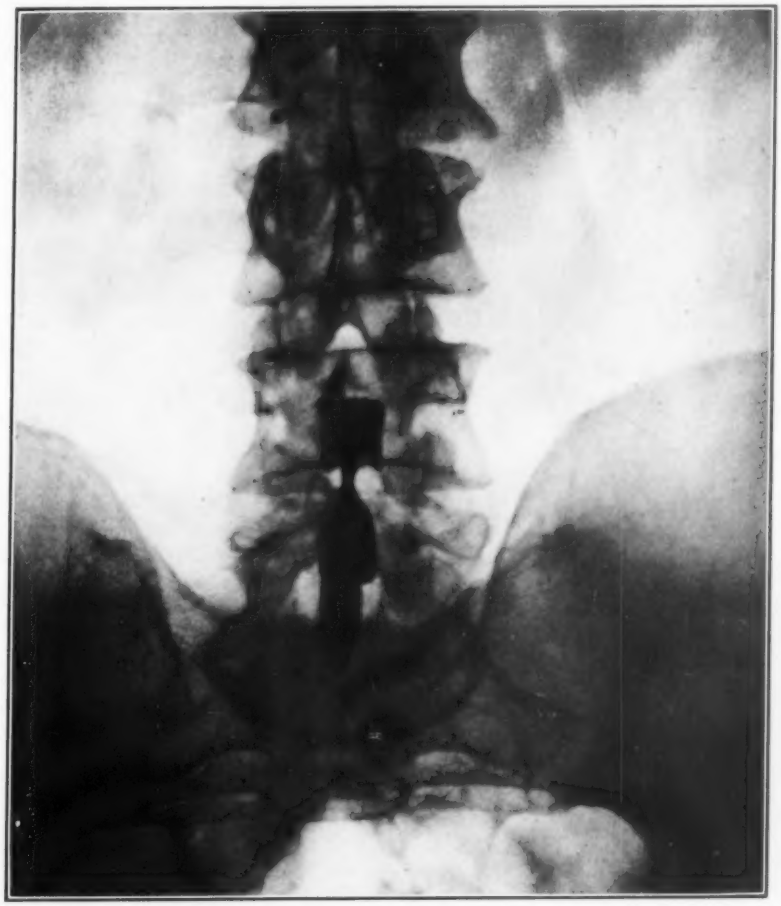

FIG. 7

Case 4. T. O'C. There is a uniform constriction of the dural sac between the fourth and fifth lumbar vertebrae.

FIG. 8

Case 5. S. C. There is a slight defect between the fourth and fifth lumbar vertebrae.

Microscopic examination of the ligament showed a fragmentation of the elastic fibers with an increase in connective tissue. The pain was relieved immediately and the patient is increasing his activities steadily. There is still some residual sensory decrease and the left Achilles-tendon reflex has not yet returned to normal.

Case 5. The patient had experienced low-back pain with unilateral sciatic radiation after a direct injury to the spine during the act of lifting; this pain had persisted for twenty-three months. Lipiodol demonstrated a unilateral defect between the fourth and fifth lumbar vertebrae. An enlarged ligament and a prominent intervertebral disc were found at operation. Improvement has been gradual.

S. C., male, thirty-seven years of age, while lifting a packing case on May 28, 1935, had slipped and fallen backward, striking his back against a hard object. He had immediate pain low in the back, chiefly on the right side and extending into the right hip. The pain radiated down the posterior aspect of the right leg. The leg felt somewhat numb and heavy, and the patient experienced some difficulty in motor control. Conservative measures, such as heat and rest, were tried without improvement. In January 1936, because of the continuation of symptoms, the transverse process of the fifth lumbar vertebra was removed. No improvement followed; in fact the patient believed that the pain and weakness of the right lower extremity were gradually increasing.

Examination on August 4, 1936, showed no spasm of the muscles low in the back; movements of the back were performed fairly well in all directions. Straight-leg raising on the right side showed only slight limitation. The right thigh was two inches less in circumference than the left, and the right calf one and five-eighths inches smaller than the left. The patient had had a compound fracture of this leg with involvement of the common peroneal nerve, which accounted for some of the atrophy. Motor power was generally decreased in the right leg. The anterior tibial muscles were much weaker in proportion than the others. The right Achilles-tendon reflex was decreased. Some sensory decrease was present on the lateral and posterior aspects of the right lower leg. Roentgenographic examinations were negative except for the absence of the transverse process removed at operation. The patient was reexamined on March 24, 1937, with essentially the same findings; his complaints had not changed. The hydrodynamics of the spinal fluid were normal; the total protein was forty-five milligrams per 100 cubic centimeters. Injection of lipiodol demonstrated a slight defect between the fourth and fifth lumbar vertebrae, suggestive of rupture of an intervertebral disc (Fig. 8).

Laminectomy was done on April 24, 1937, and an enlarged ligamentum flavum was found between the fourth and fifth lumbar vertebrae. The enlargement was more pronounced on the right side. A wide removal of the ligament, including its lateral portion, exposed the fifth lumbar root which was swollen. The intervertebral disc ventral to this root was slightly prominent, but inspection of the area showed no real dislocation.

FIG. 9

Case 6. S. A. Anteroposterior roentgenogram showing the marked constriction of the dural sac between the fourth and fifth lumbar vertebrae.

FIG. 10

Case 6. S. A. Lateral view.

This prominence, in itself, was not sufficient to produce the degree of compression which was found.

The patient has had considerable relief of pain. He has occasional paraesthesia in the area of altered sensation and the right Achilles-tendon reflex is still below normal. Epicritic sensibility is improving. His activity is being increased gradually. When one considers the duration and severity of compression of the spinal root, progress has been satisfactory.

Case 6. Low-back pain with bilateral sciatic radiation followed a direct injury to the back, and a subsequent increase in symptoms occurred after flexion of the spine. The protein content of the spinal fluid was increased. Lipiodol showed a general constriction of the dural sac. A generalized enlargement of the ligament was found at operation and relief was rapid after its removal.

S. A., male, forty-two years of age, was buried up to his chin in a cave-in of dirt in March 1936. Immediately following his release he noted pain low in the back, which persisted. He attempted to continue his work and one month later, while bending over, had a sudden snapping sensation low in the back, with an increase in pain. The pain then radiated down the posterior aspects of both legs, forcing him to stop work in August 1936. The legs became weak and the patient was unable to stand. He was

placed in traction which seemed to give some temporary improvement, although the symptoms again became worse on weight-bearing.

Examination was done on March 29, 1937. The patient complained of severe pain low in the back with radiation to both hips and occasional shocklike pains in both legs. The entire lumbar spine was hypersensitive and movements of the back were greatly restricted in all directions. The patient walked with a guarded gait, favoring the right leg. No muscle atrophy was present in either leg. There was motor weakness of all muscles in both lower extremities, most pronounced on the left. Pain inhibited some muscle movements. There was a slight decrease in sensation over the right buttock. The right patellar-tendon and Achilles-tendon reflexes were more active than the left. Roentgenograms of the lumbosacral region were negative. Spinal puncture showed normal hydrodynamics of the spinal fluid; the total protein was 110 milligrams per 100 cubic centimeters. Lipiodol studies demonstrated a marked obstruction between the fourth and fifth lumbar vertebrae (Figs. 9 and 10). A small amount of lipiodol passed down along the right side of the dural sac.

Laminectomy was done on May 7, 1937. The ligamentum flavum in this case was the most enlarged in our series,—it measured slightly over one centimeter in thickness. The dural sac and its contents were greatly constricted by the enlarged ligament and, even after removal of the ligament, the dural sac was found to be partly constricted, as was the underlying arachnoid. A spinal fusion was done following the laminectomy. Microscopic examination of the ligament showed areas in which the yellow elastic fibers were fragmented and replaced by fibrous connective tissue. A few areas of perivascular lymphocytic infiltration were seen. The patient was immediately relieved of pain and has been up and about without a recurrence of symptoms. His activity is gradually being increased and his progress has been satisfactory.

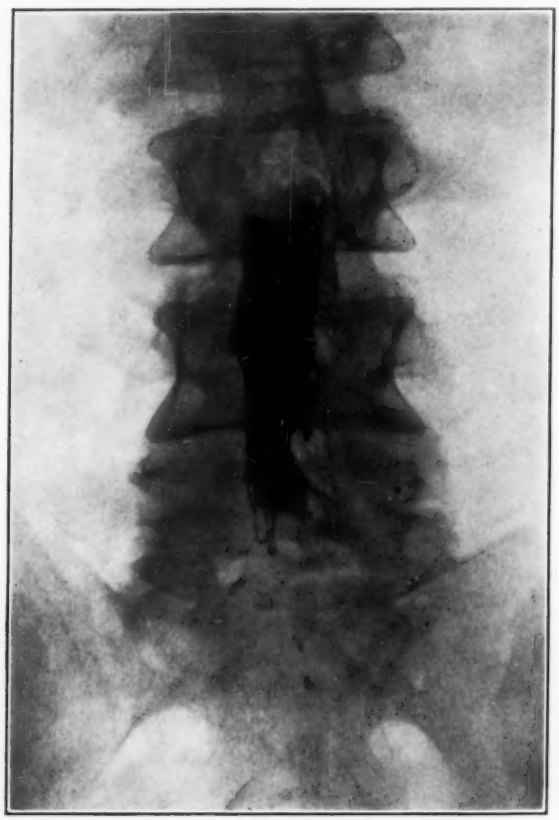

FIG. 11

Case 7. R. P. There is a defect in the column of lipiodol between the fourth and fifth lumbar vertebrae on the left.

Case 7. Low-back pain with unilateral sciatic radiation was present for eight years. There was no antecedent trauma. Lipiodol demonstrated a unilateral defect between the fourth and fifth lumbar vertebrae. An enlarged ligament, adherent to the dura, was removed at operation, with relief of pain.

R. P., male, fifty years of age, a physician, had begun to have lumbar backache and to suffer occasional attacks of acute pain in 1929. This pain had been aggravated by movement and relieved by rest in bed. In January 1930, he had had a recurrence of severe backache with left sciatic pain. During the next four years he had assumed an abnormal posture in order to reduce the frequency and severity of pain. In March 1935, he had had a severe attack of pain with radiation down the outer aspect of the left leg into the ankle. Another attack had occurred in December 1936.

Examination was made in January 1937. The left leg was colder than the right. Hyperhidrosis was noted from the toes to the middle of the calf on the left. Coughing, straining, and sneezing aggravated the pain. When examined again on July 28, 1937, the left leg was still cold, and pulsation of the left dorsalis pedis artery was absent. These indicated some coincidental vascular disturbance. Power in the left leg was markedly decreased, particularly with reference to dorsiflexion of the left foot and great toe. The left patellar-tendon and Achilles-tendon reflexes were slightly more active than the right. The left calf was a little smaller than the right. There was a painful hypaesthesia over the dorsum of the left foot and the anterolateral aspect of the lower leg, and areas of hypaesthesia were present in both calves. The hydrodynamics of the spinal fluid were normal. Lipiodol studies demonstrated a filling defect of the dural sac on the left side between the fourth and fifth lumbar vertebrae (Fig. 11).

Laminectomy was done on August 9, 1937. An enlargement of the ligamentum flavum was found, and the ligament was densely adherent to the dura. The fifth lumbar root on the left was somewhat adherent and its dural sheath was encompassed by scar tissue. Microscopic examination of the ligament demonstrated the fibrotic scarring and marked degeneration and derangement of the yellow elastic fibers common to this condition. The patient has had relief from pain, but it is too soon after operation to expect much alteration with regard to power, sensation, and reflexes.

COMMENT

Although sufficient time has not elapsed to permit a report on the end results in all of our patients, there has been relief from severe pain in all, and improvement has been continuous to the present time. It is evident also that early diagnosis and operative treatment, before compression of the nerve roots has been prolonged, will undoubtedly produce more rapid and complete recovery.

Obviously lipiodol studies should not be resorted to in all patients who have low-back pain with sciatic radiation. A thorough trial of conservative measures is indicated unless increasing evidences of neurological involvement are present. All of our patients had been treated previously by conservative orthopaedic measures, and lipiodol studies were undertaken because of persistent signs and symptoms in spite of treatment.

SUMMARY

Enlargement of the ligamentum flavum is a clinical entity producing low-back pain with sciatic radiation. Trauma of relatively slight degree was the etiological factor in the majority of our patients. Pathological changes in the involved ligaments were demonstrated microscopically.

The clinical syndrome is difficult to differentiate from lumbosacral or sacro-iliac disorders, and lipiodol studies are required in order to reach a final diagnosis. It is seldom possible to differentiate the defects in

the column of lipiodol from those produced by rupture of an intervertebral disc. Compression of nerve roots by the enlarged ligament produces the symptoms and signs. After their exit from the dura, the nerve roots lie in the very narrow space between the ligamentum flavum and the intervertebral disc. Even a slight enlargement of the ligament, a posterior protrusion of the intervertebral disc, or a combination of the two, will produce compression of the nerve roots.

Seven patients with enlargement of the ligamentum flavum were operated on over a period of seven months. This would indicate that the condition is much more common than is supposed and that many such cases have undoubtedly been overlooked in the past. Operative removal of the enlarged ligament produced prompt relief of pain with gradual improvement in the impaired motor and sensory functions.

NOTE: The author is indebted to Dr. John Saunders of the Department of Anatomy for the use of the anatomical specimen in Figure 1.

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A PROCEDURE FOR THE CORRECTION OF INTERNAL ROTATION OF THE THIGH IN SPASTIC PARALYSIS *

BY HERBERT A. DURHAM, M.D., SHREVEPORT, LOUISIANA

Those surgeons who have had much experience with the treatment of spastic cerebral paralysis are familiar with the numerous and diverse problems that arise when the correction of associated deforming contractures is undertaken. That these problems have not all been satisfactorily solved is shown by the wide variety of suggested operations for the correction of these contractures.

It is not the purpose of this article to discuss spastic contractures in general, but, rather, to deal with a specific contracture which, in the experience of the writer, has for a long time been recognized as disabling and difficult to overcome,—namely, internal rotation of the thigh. Numerous devices and procedures have been instituted to correct this deformity with heretofore unsatisfactory results.

While internal-rotation deformity may exist in the absence of other contractures around the hip, it is by far more frequently associated with the commonly found flexion-adduction contractures of the thigh, and, thus effectively masked, it does not become manifest to its full extent until the flexion and adduction have been corrected. Even then it may escape notice when the patient is recumbent, but when he stands it will be observed that one or both thighs rotate inward and flex slightly at the hip and the knee. This position interferes greatly with locomotion and renders the gait clumsy and unsightly.

The apparent cause of this was brought to the author's attention several years ago by a patient, who, after release of the flexors and adductors of the thigh and lengthening of the hamstrings, exhibited an unusual degree of internal rotation of the thigh both in recumbency and when standing. Upon attempting to passively rotate the thigh externally, it was noted that the internal rotators were extremely tense and spastic, preventing passive rotation to a neutral position. This prompted a careful anatomical study of patients in whom the correction of adductor and flexor

FIG. 1

Showing insertion of the gluteus medius and the gluteus minimus to the femoral trochanter.

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 18, 1938.

spasm had given disappointing results, and it was found that in practically all of those studied the same contracture or overactivity of the internal-rotator mechanism was present.

Of eighty-two patients with spastic paralysis admitted to the Shriners' Hospital for Crippled Children during the past six years, twenty, or approximately 25 per cent., had internal rotation of the thighs sufficient to interfere materially with walking. This indicates that spastic contracture of the internal rotators of the thighs is one of the common sequelae of spastic paralysis of the lower extremities.

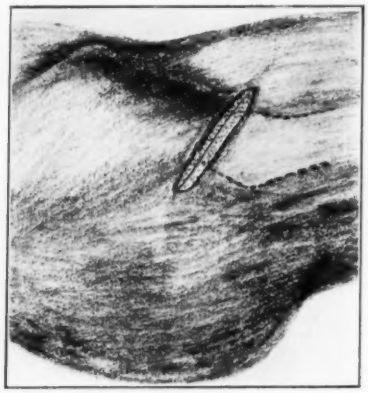

FIG. 2

Showing location of incision for release of internal rotators.

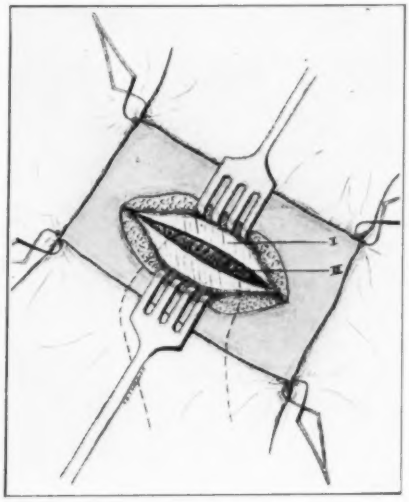

FIG. 3

I: Fascia lata divided in same line of skin incision.
II: Gluteus medius exposed.

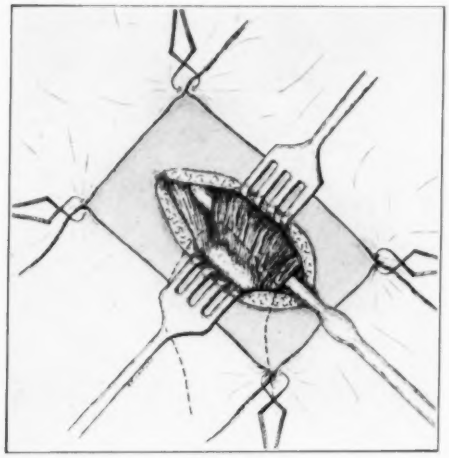

FIG. 4

Showing the portion of the gluteus medius and of the lower border of the gluteus minimus which is to be divided.

Since the anterior fibers of the gluteus medius and the gluteus minimus, assisted by the tensor fasciae femoris, constitute the effective internal-rotator mechanism of the thigh, it seemed logical to assume that a release of this mechanism would have a beneficial influence on the rotation deformity. Although the gluteus medius and the gluteus minimus are also the most important abductors of the thigh, it was reasoned that this action would not be seriously affected by a division of that part of the muscles which is attached anterior to the tip of

the greater trochanter, since the remaining superior fibers, still being spastic, would in all probability be sufficiently strong to maintain effective lateral balance of the pelvis in walking.

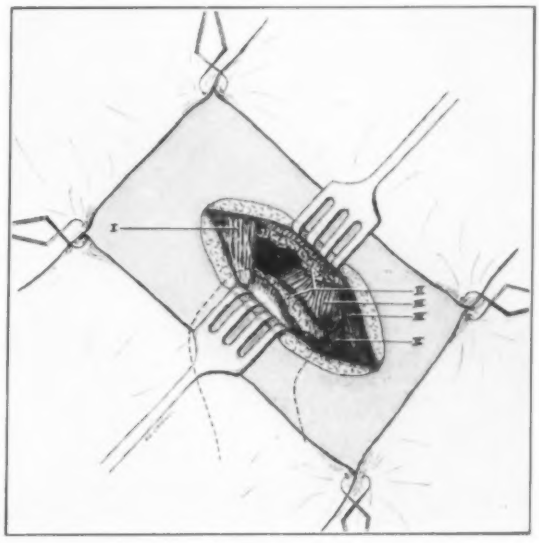

FIG. 5

I: Posterior fibers of the gluteus medius.
II: Cut anterior fibers of the gluteus medius and the gluteus minimus.
III: Capsule of the hip joint.
IV: Rectus femoris.
V: Iliopsoas.

ANATOMICAL CONSIDERATIONS

As previously stated, the most powerful rotators of the thigh are the gluteus medius, the gluteus minimus, and the tensor fasciae femoris. The distal fibers of the adductor magnus and the iliopsoas are mentioned by some anatomists as assisting in internal rotation of the thigh, but, because of their location and attachment to the femur, their function, as such, is almost negligible, and they may be ignored as far as playing any part in the production of the deformity in question is concerned. The only true internal rotators of the thigh, then, are the gluteus medius, the gluteus minimus, and the tensor fasciae femoris, with the greater part of this function being carried out by the two gluteal muscles because of their direct insertion to the greater trochanter of the femur. In patients with pronounced internal rotation of the femur, the anterior portion of these muscles can be felt as heavy cords which stand out prominently when an attempt is made to passively rotate the femur externally.

FIG. 6

Postoperative position of fixation in plaster.

The fan-shaped gluteus medius, arising from the dorsal surface of the ilium and from the fascia lata on its anterior surface, converges to the greater trochanter to be inserted by a strong short tendon into a well-marked diagonal line on its lateral

FIG. 7-A

FIG. 7-B

Fig. 7-A: C. P., aged seven years. Before operation, showing characteristic internal rotation and adduction of the right thigh.

Fig. 7-B: C. P. One year after operation, showing complete correction of internal rotation.

FIG. 8-A

FIG. 8-B

Fig. 8-A: F. T., aged ten years. Before operation, showing typical internal-rotation deformity of the right thigh.

Fig. 8-B: F. T. One year after operation, showing complete correction of internal rotation.

FIG. 9-A

FIG. 9-B

Fig. 9-A: L. B., aged thirteen years. Before operation, showing typical bilateral internal rotation of thighs.

Fig. 9-B: L. B. Six months after operation, showing complete correction of internal rotation.

surface. (See Figure 1.) The gluteus minimus, also a fan-shaped muscle, arising under cover of the gluteus medius and from the dorsal surface of the ilium, converges to the anterosuperior angle of the greater trochanter and covers the superior aspect of the capsule of the hip joint. It is inserted into the anterosuperior surface of the greater trochanter. Both muscles are fairly superficial and readily accessible at their points of insertion, being covered only by skin, subcutaneous fat, fascia, and tensor fasciae latae.

OPERATIVE TECHNIQUE

The operative technique for the release of these muscles is relatively simple. A short diagonal incision is made from behind forward immediately over the greater trochanter. (See Figure 2.) The tensor fasciae latae is divided in the line of the skin incision and retracted. (See Figure 3.) The gluteus medius and the gluteus minimus are exposed at their insertions into the greater trochanter. By rotating the thigh externally, one can put these muscles under tension, and they are thus easily identified. A grooved director or dissector is passed under that portion of the tendons which is inserted anterior and below the tip of the trochanter (Fig. 4). The tendons are then divided close to their insertions (Fig. 5). Any remaining tight fascial bands are easily detected by palpation and are likewise divided. The thigh can then be put into complete unresisted external rotation. If the fascia lata is tense and separates widely when the thigh is rotated outward, it is left unsutured and allowed to retract; otherwise it may be reapproximated. The subcutaneous fat and the skin are closed by separate layers of sutures.

Plaster immobilization is used to maintain the thigh in abduction and full external rotation. When the operation is unilateral, a single hip spica is sufficient. When the operation is bilateral, it is necessary to put on two long leg casts with a connecting bar to maintain the external rotation. (See Figure 6.) The casts are removed at the end of six or eight weeks, at which time physiotherapy and walking exercises are begun, provided the other necessary corrective procedures have been carried out.

It is conceivable that in extreme degrees of rotation of long duration there might exist some developmental shortening of the anterior portion of the hip capsule, particularly the iliotrochanteric and the iliofemoral portions of the Y-ligament. The author has never found this condition existing, but, should it be found, he sees no reason why the tight bands could not be safely divided.

END RESULTS

During the past six years, twenty patients with this deformity have been operated upon. The internal-rotation contracture was bilateral in twelve patients, making the total number of operations thirty-two. The patients have been kept under observation for periods varying from six

months to six years. Thus far the correction has been maintained in all of the cases. There have been no disturbances of locomotion that could be attributed to gluteal weakness.

SUMMARY AND CONCLUSIONS

1. Internal rotation of the thigh is a common, disabling, and persistent deformity in patients with spastic paralysis.

2. It is found mainly in conjunction with the more obvious flexor and adductor spasm, and for that reason its importance as a separate factor is apt to be overlooked.

3. The operation of anterior gluteal release is anatomically sound and technically simple.

4. Since it has given uniformly satisfactory results in a series of twenty patients, the writer has no hesitancy in presenting it as a helpful addition to the numerous surgical procedures in use for the relief of spastic contractures.

The author wishes to express his grateful appreciation and thanks to Dr. Gene D. Caldwell for the illustrative drawings and other valuable assistance in assembling the material.

EXPERIMENTAL NON-CALCIFICATION OF CALLUS SIMULATING NON-UNION

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Complete bone repair is the outcome of two processes which usually concur,—callus formation and calcification. In this investigation we separated these two processes by experimental means, so that we were able to produce uncalcified callus. Although uncalcified callus did not show up in roentgenograms (the picture being that of non-union), histological studies revealed it to be bony in character, as did the fact that it precipitously calcified under a changed experimental procedure. Thus this experiment illustrates that complete bone repair can be prevented by the failure of the second process (calcification), and that the two processes concerned in bone repair are controlled by entirely different factors.

MATERIAL AND METHODS

Twenty normal rats, four weeks old, were used in the experiment. These were fed Steenbock's rickets-producing diet consisting of 76 per cent. ground whole corn, 20 per cent. wheat gluten, 3 per cent. calcium carbonate, and 1 per cent. sodium chloride, plus 5 per cent. dried brewer's yeast. After the animals had lived on this diet for one week, they were anaesthetized and the right foreleg of each animal was broken. The fracture included both the radius and the ulna. After this procedure, the animals lived on the same diet for three weeks, when ten of them were killed, x-rayed, and autopsied. This group of animals will hereafter be called "Group A". The ten remaining animals were allowed to live four days longer, and in this period each received, in addition to the diet already outlined, about 75 international vitamin-D units in the form of viosterol. At the end of this time, they were killed, x-rayed, and autopsied. This group of animals will hereafter be called "Group B".

The two groups of animals were treated identically with the exceptions that the animals of Group B lived twenty-five days instead of twenty-one days and received vitamin D during the last four days of life.

The blood from the animals of each group was pooled for chemical examination. The right femora of the animals of each group were pooled for bone-ash estimations. The fractured foreleg of each animal was x-rayed, after which it was removed and fixed and decalcified in Bouin's fluid and sectioned by the paraffin method. Serial sections were prepared in many cases in order to obtain a comprehensive view of the fracture area. They were stained with hematoxylin and eosin.

OBSERVATIONS

Chemical Findings

The average values found for the calcium and inorganic phosphorus in the whole blood, as well as the percentage of ash in the leg bones of the animals, are given in Table I.

TABLE I

CHEMICAL FINDINGS

	Blood Calcium (*Milligrams per 100 Cubic Centimeters*)	Blood Phosphorus (*Milligrams per 100 Cubic Centimeters*)	Bone Ash (*Per Cent.*)
Group A	10.3	2.5	30.3
Group B	10.4	8.8	31.3

Roentgenographic Findings

As may be seen in the two left-hand columns of Figure 1, roentgenograms of the ten fractures in the animals of Group A showed little evidence of callus. In only three of the ten fractures was any trace of callus seen, and seven of the ten fractures presented the picture of non-union.

The two right-hand columns of Figure 1 present the roentgenograms of the ten fractures in Group B. Seven of these showed good callus formation.

The difference between the typical x-ray appearance of animals of Groups A and B is apparent in Figures 2-A and 2-B which are enlargements of the original roentgenograms. Figure 2-A shows a typical fracture in Group A, while Figure 2-B shows a typical fracture in Group B.

Microscopic Findings

Whereas the x-ray appearance of the fractures in Group A differed markedly from those of Group B, the sections of these fractures on microscopic examination proved to be strikingly similar. (See Figures 3-A and 3-B.) At the site of fracture in both groups there was excellent organic callus formation. The repair was not of the sort termed fibrous union, because the callus was composed of the same organic constituents that are seen in the repair of a normal fracture,—namely, osteogenic tissue, a certain amount of cartilage, a considerable amount of very young bone (usually termed "osteoid tissue"), and a certain amount of newly formed bone of a more mature appearance. If any difference existed in the microscopic appearance of the fractures in the two groups of animals, it was the tendency for the organic matrix in the calluses of the animals of Group B to stain somewhat more deeply with hematoxylin. (This phenomenon is usually considered indicative of calcification. We, however,

doubt the ability of hematoxylin to indicate very accurately the calcium content of tissues even when they are not decalcified, and we are completely skeptical of its ability to indicate sites of calcification in decalcified material.)

FIG. 1

The two left-hand columns are roentgenograms of the fractures in Group A. For the most part these present the appearance of non-union, although healing had been taking place for three weeks while the animals were on a deficient diet. The two right-hand columns are roentgenograms of similarly treated animals in Group B, except that these animals were allowed to live four more days, during which time they received vitamin D. In this period a well-marked callus appeared in the majority of fractures.

That well-marked typical bone repair had occurred in the fracture areas of the animals of Group A, even though it did not show on x-ray, is illustrated in Figures 3-A and 3-B. Figure 3-A is a section of a fracture in an animal from Group A which showed no evidence of callus on roentgenographic examination. Figure 3-B is a typical section from a healing fracture in Group B.

DISCUSSION

The Reason for Using Two Groups of Animals

In this experiment we wished to make observations on the blood and fractured bones of animals living for three weeks after the fracture on a deficient diet. We also wished to learn what changes would occur in these animals after the diet was changed. It is literally impossible to obtain these findings and have the animals live afterward, so we could not get both sets of observations from any single animal. Hence we used two groups which, until three weeks after the fracture, were treated identically. At this time the animals in the first group, A, were killed, and the diet was changed in Group B which were kept for four more days. Thus observations on Group A represent the state of affairs in Group B four days before they were killed, and the changes which occurred in that time must have been caused either by the four extra days' healing or the changed diet. As four days was such a small fraction of the total time of the experiment, it seems logical to conclude that the differences in the findings between the animals of Groups A and B were caused by the vitamin D given in the four days at the end of the experiment.

FIG. 2-A

Example of fracture in Group A (enlarged).

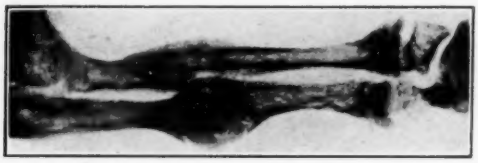

FIG. 2-B

Example of fracture in Group B (enlarged).

The Terms "Non-Union" and "Non-Calcification"

Like so many definitions in present-day use, certain of those used commonly in regard to fractures are decidedly inadequate. For instance, the terms "non-union" and "ununited fracture" are employed to indicate the absence of bony union. Hence "fibrous union" is an example of "non-union". It is a problem to decide whether a fracture which is united by a callus, the organic constituents of which are similar to bone but which are not calcified, should be called "non-union". To settle this question, it becomes necessary to decide whether bone tissue is distinguished from other tissues by its organic constituents or by its

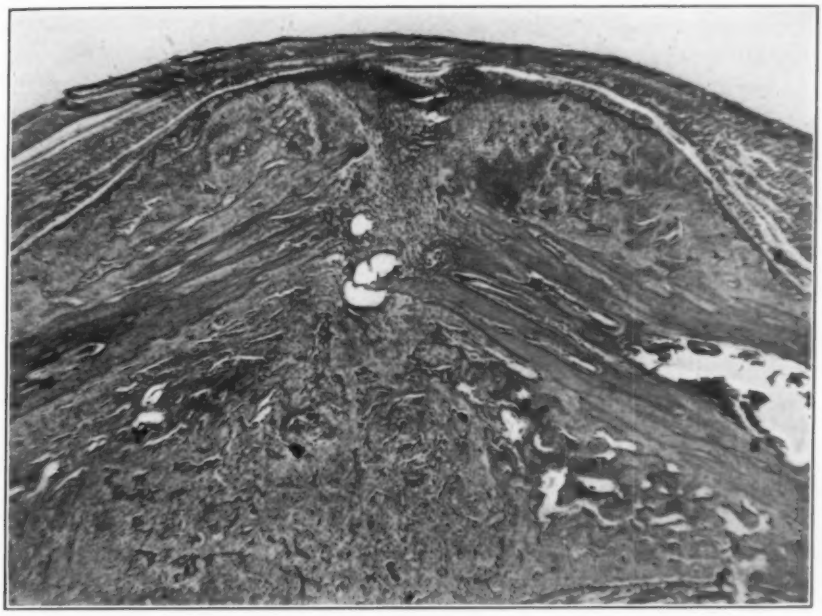

FIG. 3-A

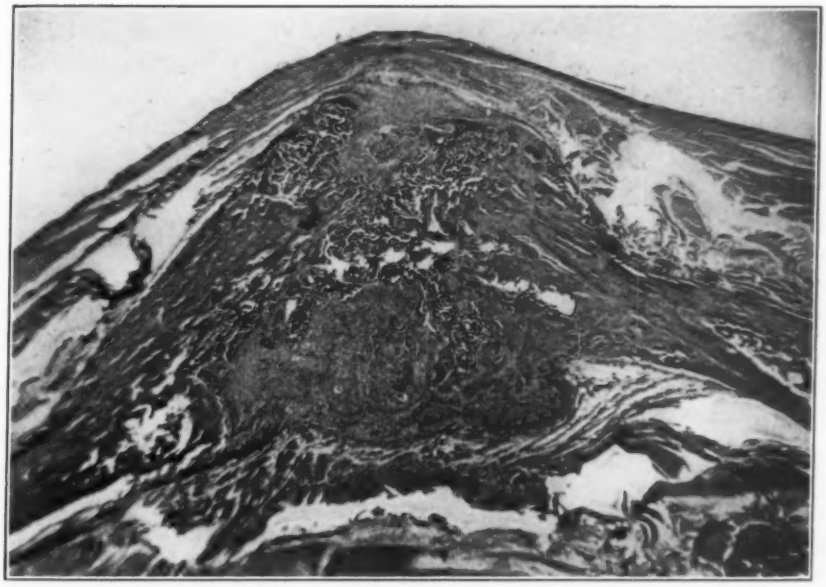

FIG. 3-B

Figure 3-A is a typical example of the histological appearance of a fracture in an animal from Group A; Figure 3-B shows a section of a fracture in an animal from Group B. It is apparent that the administration of vitamin D for four days did not markedly change the histological appearance of the callus tissue, which is abundant in both fractures.

inorganic constituents. In this connection it should be pointed out that other tissues can calcify, taking up exactly the same salts that bone does, but this does not make these tissues into bone. For instance, calcified cartilage is not bone. Consequently, although bone is almost always calcified, and although calcification is its most impressive feature, it is not its distinguishing one. In the last analysis, bone is distinguished from other tissues by the character and arrangement of its organic constituents, and this experiment revealed that these are very similar in uncalcified and calcified bone (callus in Groups A and B). Thus we take the position that the fractures in Group A were examples of true bony union even though the bone was not calcified. Hence "non-calcification" is not "non-union".

Possible and Not Uncommon Misinterpretations of Action of So-Called "Calcifying Agents"

The difference between the findings of Groups A and B existed in the x-ray appearances and the blood, and not in the histological sections. However, if the latter had not been studied, it would have been very easy to conclude from the x-ray appearances that vitamin D had caused a remarkable growth of callus in the four days when it was given. Investigation of the histological picture, however, revealed that a good organic callus was in existence before the vitamin D was given and that the vitamin D had no effect on its organic structure. Hence vitamin D does not affect the growth of callus. What it does affect can also be readily misunderstood. If blood findings had not been available in this experiment, it would have been easy to conclude that vitamin D acted as a specific calcifying agent. However, reference to the blood-phosphorus figures reveals that this mineral existed in such small amounts in the blood previous to the vitamin-D administration that calcification could not occur. After vitamin D was given, the blood-phosphorus level rose quickly to a point where normal calcification was able to proceed in the callus which was avid for a calcium-phosphate precipitate. Consequently vitamin D should not be thought of as a specific local calcifying agent, but rather as only one of the many factors concerned in affecting the general calcium and phosphorus metabolism. In this particular experiment it was a marginal factor.

The Two Aspects of Bone Repair and the Factors Which Control Them

As this experiment allowed the separation of the two processes—the growth of callus and its calcification—it illustrates that the two processes are controlled by entirely different factors. Consequently, it is easy to see that there is little use in taking therapeutic measures to affect one process (for instance, calcification) when the other process is at fault. As a matter of fact, we know remarkably little about those factors which cause reparative tissue to grow when a bone is broken or even when any other tissue is injured. We are much better informed, however, in

regard to the factors which control the second aspect of bone repair,—namely, calcification. This process is now thought to occur in bone as follows: The fluids surrounding bone matrix are saturated with respect to calcium phosphate, but contain in addition both calcium and phosphorus in other forms, some of those being bound organic compounds. Osteoblasts in the newly forming bone secrete the enzyme phosphatase which splits certain of those bound phosphates, so that additional phosphate ions are liberated in the vicinity. As the solution is already saturated with calcium phosphate, the addition of extra phosphate ions, by mass action, drives down a precipitate of calcium phosphate (the precipitate is more complex, but this is disregarded for the sake of simplicity), and this precipitate is taken up by bone matrix which has a physicochemical affinity for it.

Possibility of Non-Calcification in Human Cases

This experiment suggests the possibility that the x-ray picture seen in certain cases, which leads to the diagnosis of meager or tardy callus formation or even non-union, is at least partially accounted for by non-calcification of the callus. At first thought it might be considered that such a possibility could be immediately ruled out by determining the blood calcium and phosphorus level of the patient. Lest too hasty a decision be made upon this matter, it is well to remember that the state of these elements of the blood is just as important as are their amounts, and a great deal remains to be learned about the state of these minerals in the blood. To illustrate this point, an acidosis probably causes a change in the character of the calcium phosphates of the blood, shifting them to the more acid salts which are much more soluble and correspondingly more difficult to precipitate. However, we must await future investigations before we can understand and perhaps remedy various disturbances of the state of the calcium and phosphorus of the blood which would prevent precipitation in bone even though the level of these substances in the blood is normal. In the meantime, although defective bone repair is probably almost always the result of the failure of the first process—the growth of a proper callus—it seems worth while to keep in mind the possibility that the x-ray picture can result from a failure of the second process.

SUMMARY AND CONCLUSIONS

In this study, fractures were produced in animals which were being fed a diet that deranged their calcium and phosphorus metabolism.

At the end of three weeks, roentgenograms gave the impression that no union had occurred, but histological examination showed the presence of an excellent callus of bony tissue, although it was uncalcified.

Similarly treated animals, allowed to live four days longer and given vitamin D during this period, showed a rapid calcification of the bony callus which was, of course, already in existence. This rapid calcification

of callus was noted in the roentgenograms. The histological appearance of the fractures changed little in this time.

Non-calcification of a callus is not non-union, because bony union is judged as such by the character and arrangement of the organic constituents of callus and not by its mineral content.

Vitamin D and other so-called calcifying agents do not control the formation or growth of a callus, and only indirectly affect its calcification.

As this experiment clearly separates the two phases of bone repair and illustrates that x-ray appearances of healing can be prevented by a failure of calcification even though a good organic callus is present, it is futile to adopt therapeutic measures directed at one process when the other is at fault, because the two processes are controlled by entirely different factors.

The possibility that certain cases of apparent meager or tardy union or even non-union in human beings are in reality cases of non-calcification should be considered.

PNEUMOROENTGENOGRAPHY OF THE KNEE JOINT *

An Analysis of Fifty Cases

BY PAUL A. QUAINTANCE, M.D., F.A.C.S., LOS ANGELES, CALIFORNIA

A combination of insufflation with oxygen, carbon dioxide, or atmospheric air, and roentgenography has been used successfully in demonstrating and differentiating injuries to and diseases of the soft-tissue structures of the knee (Kleinberg, Balensweig, Bernstein and Arens, Friedrich, Rechtman, Cattaneo, and Simon, Hamilton, and Farrington). The writer is herewith reporting briefly his experience with pneumoroentgenography as such an aid in diagnosis in fifty patients studied during the last seven years.

INDICATIONS

Pneumoroentgenography is indicated in cases of long standing, when injury and locking are questionable and, also, when plain roentgenograms disclose no evidence of injury or reveal impacted fracture of the tuberosity of the tibia or avulsion fracture of the condyle of the femur. By this means is made possible differentiation of fractured, loose, or displaced menisci, injury to the cruciate ligaments, fracture of the spines of the tibia, chronic villous synovitis, hypertrophy of the fat pad, and loose bodies in the joint. The method is of value in localizing the seat of pathology and in demonstrating multiple lesions or lesions of soft tissues, symptoms of which are masked by injuries to the bone.

Reports in the literature and the author's own limited experience indicate that the procedure is harmless. However, Kleinberg, in 1927, reported a case of non-fatal pulmonary embolism following an unsuccessful attempt at insufflation of a knee by a hospital resident. No reports of infections attributable to the procedure have come to the writer's attention, and no infections have occurred in this series. One of the author's patients had a fainting spell on the x-ray table, with recovery after a few minutes.

TECHNIQUE

Under local infiltration anaesthesia, with the knee relaxed in slight flexion on the x-ray table, the joint is insufflated with atmospheric air. Any fluid present is aspirated. A moderate degree of distention of the joint is effected by the injection of from 100 to 150 cubic centimeters of air with an ordinary Luer syringe and needle with a stop-cock.

Stereoscopic anteroposterior and plain lateral roentgenograms are

* An abbreviation of a paper read before the Industrial Medicine and Surgery Section of the California Medical Association at the Sixty-Fifth Annual Session, Coronado, California, May 25 to 28, 1936.

made, using a soft-tissue-detail technique. The air is released, the needle is withdrawn, and a sterile dressing and an elastic bandage are applied.

ANATOMY AND MECHANISM OF INJURY TO MENISCI

The medial meniscus is densely adherent to the capsular and tibial collateral ligaments by fibrous strands and is firmly and closely attached to the rim of the tibia by the fibrous coronary ligaments. Normally the meniscus is only slightly mobile, its anterior horn receding about one-eighth of an inch (three-tenths of a centimeter) posteriorly into the joint when the leg is flexed beyond 20 degrees. The anterior horn has two insertions,—one to the tuberosity of the tibia, the other to the capsule of the joint through the transverse ligament (Cunningham). This dual insertion of the anterior horn, the relative lack of mobility of the medial meniscus, and the wider range of circular, gliding motion of the medial tuberosity of the tibia on the medial condyle of the femur predispose the medial meniscus to disruption and tear when the flexed knee is under stress.

The lateral meniscus, although firmly attached to the capsular ligament, is very loosely adherent by areolar tissue to the fibular collateral ligament. This meniscus is more mobile, and the range of movement of the lateral tuberosity of the tibia on the lateral condyle of the femur is less. Hence, the lateral meniscus is less subject to stress and is infrequently injured.

In the cadaver *, with the coronary ligaments of the knee intact, both menisci are observed to recede fully one-eighth of an inch (three-tenths of a centimeter) posteriorly into the joint during flexion and to resume their normal position and convex contour during extension. When the coronary ligaments are severed anteriorly, recession of the menisci during flexion increases to as much as three-eighths of an inch (one centimeter). On extension, the menisci fail to resume their normal position and contour and are impinged between the femoral condyles and the tibial tuberosities. Full extension of the leg is not possible. Rupture of the coronary ligaments, therefore, predisposes to displacement, impingement, and bruising of the menisci and limitation of extension or locking of the knee.

ANALYSIS OF CASES

Clinical and pneumoroentgenographic studies were made on fifty patients,—forty-seven males and three females. The right knee was involved in thirty-two cases; the left, in eighteen.

A history of a twist was given by thirty-two patients, twenty-four of whom stated that the knee was flexed when the accident occurred. Thirteen had a direct blow about the knee. Seven reported that the knee had been forced medially or laterally; in four cases this had been in association

* Dissections done through the courtesy of Dr. Paul McKibben, Professor of Anatomy, University of Southern California Medical School.

TABLE I

ANALYSIS OF TWENTY-FOUR OPERATIONS ON THE KNEE

Type and Location of Pathology	Pneumoroentgenographic Diagnosis *No. of Cases*		Operative Findings *No. of Cases*		Diagnosis Verified *Per Cent.*	Remarks
Fracture of meniscus:						Four previously undiagnosed fractures found at operation. In three cases no operation was performed.
Medial	11		12			
Lateral	2		2			
	—	13	—	14	71	
Displacement of meniscus:						One previously undiagnosed case found at operation. In four cases no operation was performed.
Medial	11		9			
Lateral	4		3			
	—	15	—	12	91	
Fracture-displacement of meniscus:						
Medial	4		4			
Lateral	1		1			
	—	5	—	5	100	
Loose bodies		8		3	100	In five cases no operation was performed. In one of the patients operated upon the plain x-ray had failed to show the loose body.
Pedunculated bodies		0		1	0	

with a direct blow. Five patients had slipped, ten had fallen, and two had stumbled.

Forty-two patients complained of immediate pain in the knee; twenty-three were unable to extend the leg fully immediately after the accident. Three patients complained of having felt a click or snap, and four had noticed black and blue coloration. Recurrence of symptoms caused twenty-eight, or 56 per cent., of the patients to seek medical attention weeks or months, and in one instance over three years, after the original injury.

Physical examination disclosed tenderness anteromedially in twenty-two patients, anterolaterally in five, medially in four, and laterally in two. Three had tenderness both medially and anteromedially and two had tenderness on the anteromedial and anterolateral surfaces of the knee. In sixteen knees swelling was observed, and from six of them from ten to forty cubic centimeters of fluid was aspirated prior to taking pneumoroent-

FIG. 1-A

Case 9. A. G. H., July 1, 1931. The shadow of the medial meniscus (anteroposterior view) is normal in position and appearance.

FIG. 1-B

Case 9. A. G. H., July 1, 1931. The hypertrophied retropatellar fat pad (lateral view) projects into the intercondylar notch even when the joint is distended. It also is seen quite clearly in Fig. 1-A.

genograms. There was limitation of extension in twenty-four patients and of flexion in eighteen. Instability at the knee was found in six cases, resulting from fracture of the lateral tuberosity of the tibia in two cases, avulsion fracture of the condyle of the femur in two, and injury to the cruciate ligaments in two. There were findings indicating sprain of the tibial collateral ligament in eleven patients and of the fibular collateral ligament in two.

In two patients solitary loose bodies were palpated about the knee.

PNEUMOROENTGENOGRAPHIC AND OPERATIVE FINDINGS

Of the fifty knees of which pneumoroentgenograms were taken, twenty-four, or 48 per cent., were subjected to arthrotomy. As shown in Table I, fracture of a meniscus (medial in eleven, lateral in two) was diagnosed in thirteen patients, only ten of whom came to operation. Diagnosis of a fractured meniscus was confirmed in all ten. Fracture of a meniscus was found in four additional knees in which it had not been demonstrated by the pneumoroentgenograms. In one of these, however, displacement had been diagnosed. Therefore, the percentage of correct diagnoses of fracture of the meniscus proved by arthrotomy was 71. In three unoperated patients the diagnosis was not confirmed.

Displacement of a meniscus (medial in eleven, lateral in four) was diagnosed by pneumoroentgenography in fifteen patients, in eleven of whom the diagnosis was confirmed by arthrotomy. In an additional patient

displacement was found in a knee in which fracture of a meniscus had been diagnosed. The percentage of correct diagnoses of displacement of the meniscus, as verified by arthrotomy, was 91.

In five patients in whom both fracture and displacement of a meniscus were diagnosed by pneumoroentgenography, the diagnosis was proved by arthrotomy, making the percentage of correct diagnoses of fracture-displacement of the meniscus 100.

Of the eight patients in whom loose bodies were diagnosed by pneumoroentgenography, three submitted to operation and the diagnosis was proved. In one of these patients plain x-rays prior to pneumoroentgenography had failed to demonstrate a loose body.

A pedunculated body, which the pneumoroentgenogram had failed to demonstrate, was found at operation in another patient.

Baker's cysts (single, unilocular, multilocular, and multiple) were demonstrated in four patients.

Hypertrophic arthritic changes were present in the x-rays of eight patients.

Fractures of the distal end of the femur were observed in two patients and fractures of the proximal end of the tibia in five.

In six patients no pathology in either bony or soft tissues was demonstrated.

FIG. 2-A

Case 17. G. G., March 4, 1932. Note absence of the shadow of the lateral meniscus from its usual position. Note also that the lateral and medial joint spaces are of equal width.

FIG. 2-B

Case 17. G. G., March 4, 1932. Note abrupt break in continuity and upward displacement of the lateral meniscus, fracture defect in the lateral condyle, and narrowing of the lateral tibiofemoral joint space.

FIG. 3-A

Case 17. Gross longitudinal section of injured lateral meniscus, showing site of fracture, areas of degeneration, vascularization, and replacement by fibrous tissue.

REPORTS OF ILLUSTRATIVE CASES

CASE 9. A. G. H., male, twenty-eight years old, a bookkeeper, on May 13, 1931, experienced pain on the anteromedial surface of the right knee in squatting after a broad jump. For two months he frequently felt something "go out of place and snap in after a few movements", during which intervals extension was limited.

Examination revealed tenderness anteromedially and slightly limited extension.

Pneumoroentgenograms (Figs. 1-A and 1-B), taken on July 1, 1931, after the aspiration of ten cubic centimeters of thick, amber, clear fluid, showed a large, dense triangular shadow in the anterior intercondylar notch, which was interpreted as a hypertrophied fat pad. Although the history and physical findings were typical of disruption of the medial meniscus, such injury could not be demonstrated. Arthrotomy was not done. Three months later the patient was reported to be "getting along well".

Diagnosis: Hypertrophy of the retropatellar fat pad.

CASE 17. G. G., male, forty-five years old, a timberman, on April 28, 1931, was buried when a trench caved in. Pain, wobbling, recurrent locking, limited flexion in the left knee, and disability were complained of for eight months.

Examination revealed tenderness laterally, slight lateral instability, restriction of flexion, and atrophy of the thigh muscles. Climbing stairs caused increased pain, swelling, and recurrence of locking. Plain x-rays had revealed a small ununited avulsion fracture of the lateral condyle, to which the symptoms had been attributed.

Pneumoroentgenograms (Figs. 2-A and 2-B), taken on March 4, 1932, disclosed a fracture of the lateral meniscus and an oblique shadow of cartilaginous density in the lateral compartment of the joint. The lateral joint space was narrow and the cartilage shadow was absent from its usual position. A diagnosis of fracture-dislocation of the *lateral* meniscus was made. Two orthopaedic surgeons diagnosed injury to the *medial* meniscus.

Medial meniscectomy, on March 31, 1932, revealed insufficient pathology to explain the symptoms. A second incision laterally disclosed a transverse rent in the joint capsule, and fracture, and upward lateral displacement of the anterior horn of the lateral meniscus. Lateral meniscectomy also was done.

Longitudinal section (Fig. 3-A) through the region of the fracture showed clearly the abrupt fragmentation and partial degeneration and regeneration of the anterior horn. The microscopic picture of the fatty degeneration, vascularization, and proliferation of connective tissue which followed the injury is shown in Figure 3-B.

Diagnosis: Fracture-dislocation of the lateral meniscus.

CASE 24. L. D., male, thirty-six years old, a wire worker, while stepping up on an iron horse on April 22, 1932, experienced snapping, pain, and locking of the right knee. Manipulation under anaesthesia gave no relief.

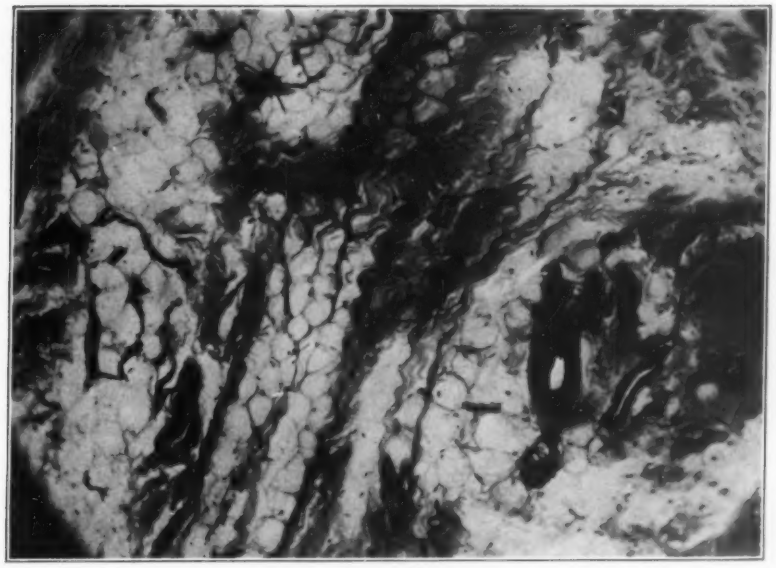

FIG. 3-B

Case 17. Photomicrograph of area of degenerative and regenerative changes in injured cartilage.

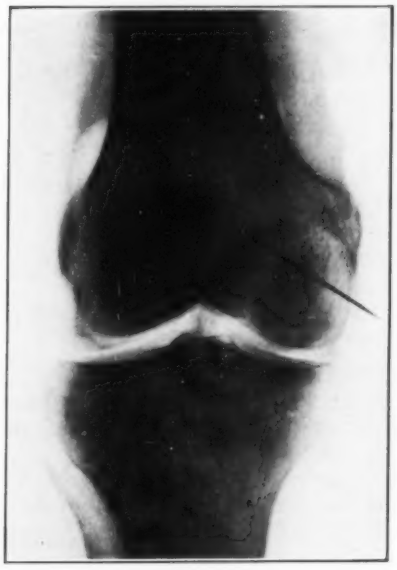

FIG. 4

Case 24. L. D., June 17, 1932. The displacement and elevation of the anteromedial portion of the medial meniscus from the articular margin of the tibia is shown by the air space between them. Note the normal juxtaposition of the lateral meniscus and the lateral tuberosity of the tibia.

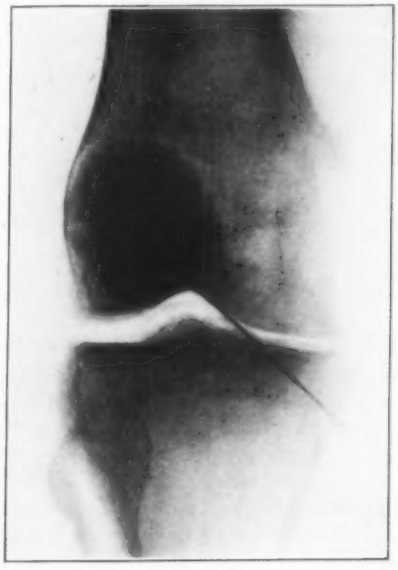

FIG. 5

Case 28. B. E., September 28, 1932. The air space distal to the lateral meniscus indicates rupture of the coronary ligaments, allowing displacement; the mottling denotes fatty degeneration of cartilage. A portion of the longitudinal fracture of the meniscus found on arthrotomy can be seen as a transverse line near the anterior horn.

FIG. 6-A

Case 30. L. S., November 22, 1932. Fracture defect in the lateral tuberosity and narrowing of the lateral tibiofemoral joint space are seen in this pneumoroentgenogram taken with the limb relaxed.

FIG. 6-B

Case 30. L. S., November 22, 1932. Note absence of the shadow of the lateral meniscus from the joint space. Arthrotomy revealed it in position of the shadow adjacent to the lateral condyle of the femur.

Examination revealed slight fluctuant swelling and moderate restriction in flexion and extension. The cartilage spring test was positive on the medial side.

The first pneumoroentgenograms, taken on April 22, 1932, after aspiration of twenty cubic centimeters of bloody fluid, were not diagnostic, although the medial meniscus was mottled near the collateral ligament. A follow-up pneumoroentgenogram (Fig. 4), taken on June 17, 1932, showed elevation of the anterior portion and an oblique fracture of the medial meniscus at the junction of its middle and anterior portions.

Arthrotomy on July 22, 1932, disclosed a bucket-handle fracture, contusion, and upward displacement of the middle portion of the medial meniscus.

Diagnosis: Bucket-handle fracture and displacement of the medial meniscus.

CASE 28. B. E., male, twenty-seven years old, an iron worker, twisted his right knee on August 8, 1932, while squatting, and had recurring pain and locking for six weeks. This knee had been sprained three and two years previously.

Examination revealed tenderness anterolaterally and posteriorly to the head of the fibula, slight limitation of flexion and extension, and a positive cartilage spring test.

A pneumoroentgenogram (Fig. 5), taken on September 28, 1932, showed thinning, mottling, and upward displacement of the lateral meniscus.

Arthrotomy on October 7, 1932, disclosed a longitudinal fracture, detachment, and upward displacement of the anterior horn, the tip of which remained attached.

Diagnosis: Fracture-displacement of the anterior horn of the lateral meniscus.

CASE 30. L. S., male, thirty-seven years old, a salesman, on June 7, 1932, doubled his left knee under him in falling off a truck. For five and one-half months there was persistent pain laterally with a tendency to "give way".

Examination revealed tenderness and crepitus anterolaterally and slight anteroposterior instability.

Serial pneumoroentgenograms (Figs. 6-A and 6-B), taken on November 22, 1932, showed the lateral *attachment* of the lateral meniscus to be displaced upward five-eighths of an inch and a healed impacted fracture of the lateral tuberosity of the tibia. The second pneumoroentgenogram, with pressure exerted laterally, showed widening of the lateral joint space and upward displacement of the meniscus.

Arthrotomy on November 29, 1932, disclosed detachment and displacement of the entire lateral meniscus with the exception of the insertion of its anterior horn.

Diagnosis: Displacement of the lateral meniscus complicating fracture of the tuberosity of the tibia.

SUMMARY

In this study pneumoroentgenography, using atmospheric air, was done on fifty knee joints.

Hypertrophy of the retropatellar fat pad, indicative of chronic synovitis or injury, was demonstrated in twenty-one knees. The pad was palpably enlarged in only seven patients.

Baker's cysts were demonstrated in four knees.

Fracture of the meniscus was diagnosed by pneumoroentgenography in 71 per cent. of the knees in which fractured menisci were found at operation. Three knees remained unoperated.

Displacement of a meniscus was diagnosed in 91 per cent. of the knees in which a displaced cartilage was found on arthrotomy.

Fracture-displacement of a meniscus was verified by arthrotomy in 100 per cent. of the knees in which this diagnosis was made.

Loose bodies were diagnosed in eight knees and removed from the three knees operated upon. One undemonstrated pedunculated body was found at operation.

Thirty-two knees had suffered a twist; in twenty-four, or 75 per cent., the accident had occurred while the knee was flexed. In twenty-four, or 48 per cent. of the fifty cases, there had been limitation of extension.

CONCLUSIONS

Pneumoroentgenography is a simple, harmless, practicable, and valuable aid in the differential diagnosis of injuries and diseases of the soft-tissue structures of the knee.

Its efficiency in demonstrating fracture and displacement of the menisci, as verified by arthrotomy, was 87 per cent. in this series.

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POSTERIOR HERNIA OF THE KNEE JOINT

A Cause of Internal Derangement of the Knee *

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The object of this paper is to direct attention to the occurrence of synovial cysts in the popliteal space, and in particular to one type of cyst which at operation is found to be a posterior hernia of the knee joint. In the presence of such pathology the patient's symptoms suggest an internal derangement of the knee. Hence, with patients who complain of knee-joint disability, it is always important to examine the popliteal space for the presence of a swelling. This examination is most informative if the patient bears weight on the extremity and if the knee is held in a position of complete extension. If a cystic swelling is noted, the greater part of which is distal to the transverse skin crease in this region (Fig. 1), then posterior hernia of the joint may be the cause of the symptoms.

FIG. 1

Case 1. A localized, well-developed cystic swelling of the popliteal space.

In reviewing the literature, the first accurate description of an abnormal synovial swelling in the popliteal space was found in a short clinical report, "Chronic Rheumatic Arthritis of the Knee Joint", by Adams in 1840. Todd also attributed this "dropsical condition of the popliteal bursa" to chronic rheumatic arthritis.

In the papers published by Gruber, beginning in 1845, a complete study of these cases was presented. The anatomy of enlarged bursa in the popliteal space, as well as true posterior hernia of the knee joint, was described. Billroth, in his textbook, "General Surgical Pathology", accepted Gruber's conclusions.

More than thirty years after publication of the articles by Adams and Gruber, Baker, of St. Bartholomew's Hospital, London, discussed the formation of synovial cysts in the leg in relation to disease of the knee joint. This author believed that the cysts were caused by osteo-arthritis of the knee, an opinion based on the findings at dissection of amputated extremities. In two communications, Baker reported his observations on ten patients with cystic swelling about the knee. In three cases, the examination after amputation indicated there was a true posterior hernia

* Read before the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

of the joint. In the remaining cases either infection did not occur, and hence pathological examination was not possible, or the cyst was apparently an enlargement of one of the joint bursae. As a result of these case reports, any cystic swelling about the knee with a cellular lining similar to that of synovial membrane is often referred to in the English literature as a Baker's cyst.

Posterior hernia of the knee joint or hyperplasia of an adjacent bursa is the cause of a synovial cyst in the popliteal space. From the clinical standpoint, the essential difference between the two conditions is that, although an enlarged bursa may communicate with the joint, a posterior hernia always exhibits this relationship and is the cause of symptoms characteristic of an internal derangement of the knee. This clinical syndrome is not now widely recognized and hence the present series of cases is reported.

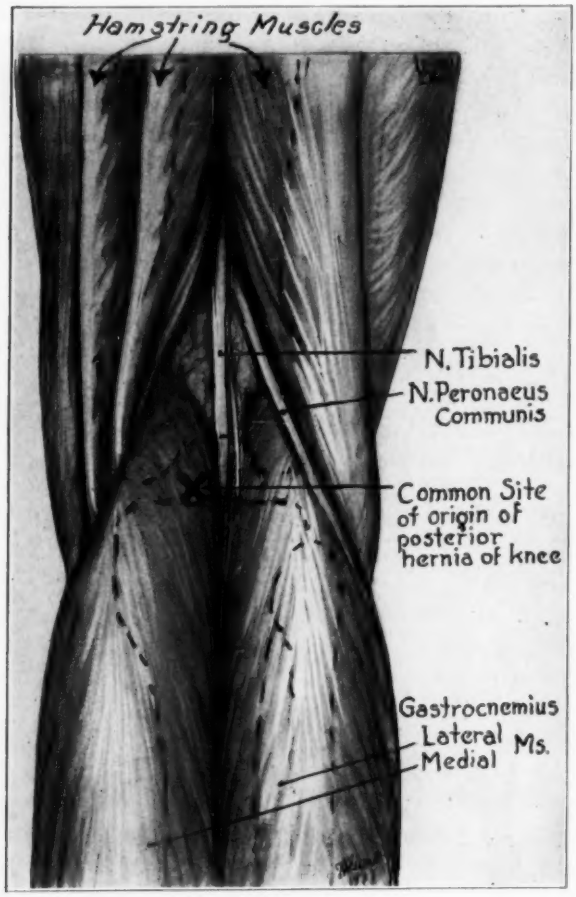

FIG. 2

Normal anatomy of the popliteal space. Posterior hernia of the knee joint usually arises below the oblique popliteal ligament of the joint capsule and just medial to the mid-line, as indicated.

In consideration of the anatomy of the popliteal space (Fig. 2) and the distance of the joint capsule from the skin surface, it is reasonable to assume that in the early stages herniation would not cause undue symptoms, nor would it be possible to detect clinically. That is particularly true because of the subcutaneous fat pad which overlies this space and from which, incidentally, it is often difficult to differentiate a true posterior hernia of the joint. Gradually increasing in size, the sac dissects its way through the soft fatty tissue of the popliteal space, in the line of least resistance, and finally lies between the two heads of the gastrocnemius muscle. With further in-

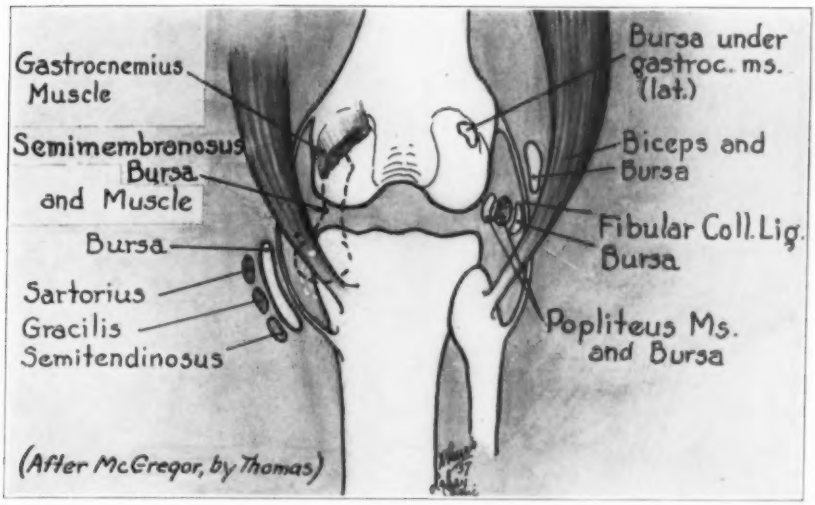

FIG. 3-A

Diagrammatic drawing showing location of bursae about the posterior knee region.

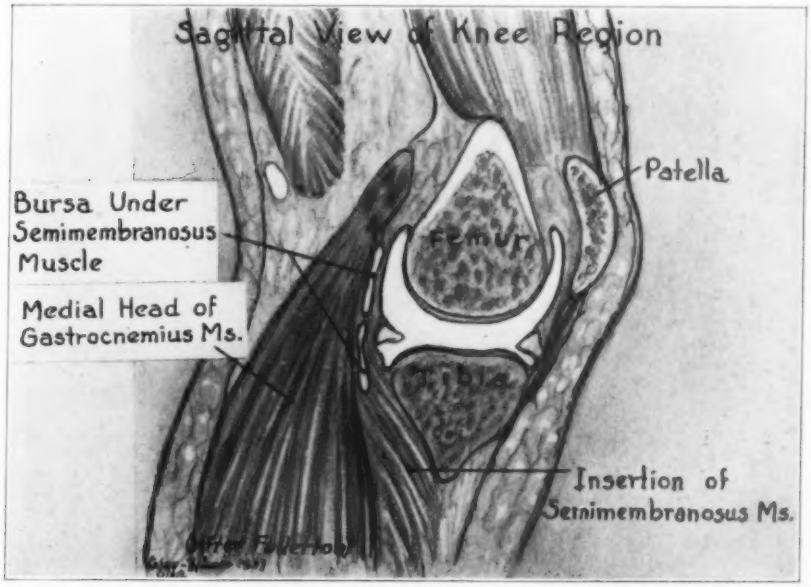

FIG. 3-B

Diagrammatic drawing illustrating the anatomical relationship of the semimembranosus bursa which most frequently communicates with the knee joint.

crease in size, the sac then extends down the leg under the deep fascia, as a rule more on the mesial than on the lateral aspect of the calf. In three patients the distal end of the sac reached the mid-calf region.

Of the twelve bursae around the knee joint, two are posterior (Fig. 3-A) and are found between each head of origin of the gastrocnemius muscle

FIG. 4-A

Case 2. Photomicrograph (× 48) showing part of the wall of the hernial sac with pseudocystic outpocketing from that wall. Note the marked vascularity and round-cell infiltration of the subserous layer. *(Courtesy of Dr. Shields Warren.)*

FIG. 4-B

Case 2. Photomicrograph (× 200) showing lining of the pseudocyst and outpocketing. Note particularly that the fibrous-tissue wall is lined with typical synovial cells. (*Courtesy of Dr. Shields Warren.*)

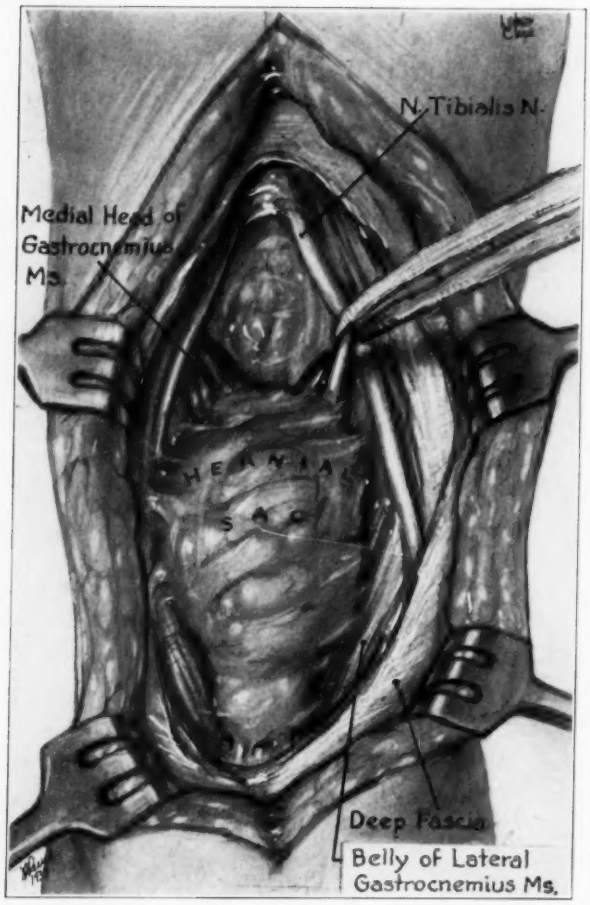

FIG. 5

Exposure of the hernial sac following division of the deep fascia and preliminary dissection. Note the adhesions to the gastrocnemius.

and the joint capsule. They may communicate with the knee joint, particularly that bursa beneath the inner head of the gastrocnemius which sends a prolongation between this muscle and the semimembranosus, and which is termed the semimembranosus bursa (Fig. 3-B). One patient was operated on for enlargement of this bursa, but the swelling was definitely located at the inner side of the popliteal space, and the dissection at operation clearly revealed the point of origin from beneath the medial head of the gastrocnemius muscle. A definite communication with the joint was not demonstrated in this case.

In eight patients the hernial sac communicated with the knee joint by a short pedicle which averaged one centimeter in length, with walls of quite dense connective tissue. The opening in the posterior capsule was usually below the oblique popliteal ligament and slightly medial to the mid-line. The distal wall of the larger sacs was quite thin and firmly adherent to the tendon fibers of the gastrocnemius muscle.

On histological examination, the lining of the hernial sac and of the enlarged bursa was found to be a true mesothelium (Figs. 4-A and 4-B), in every way similar to the lining of the knee joint. In all of the specimens removed there was acute and chronic inflammation of the serous lining, together with a moderate to marked round-cell infiltration in the subserous layers. The outer wall of the sac, adjacent to the site of origin, was composed of relatively dense fibrous tissue similar to the capsule of the knee joint, while the more distal portion was a fine connective tissue

quite friable and easily ruptured.

The most difficult differential diagnosis in these cases is to distinguish between a true posterior herniation of the joint or hyperplastic bursitis and a lipoma in the popliteal space or the usual fat pad that is present. The majority of true herniae in this region vary somewhat in size and likewise give rise to a varying degree of subjective symptoms. Furthermore, the popliteal swelling due to posterior joint hernia is in greater part distal to the transverse skin crease of this region. In obese patients, the deposit of fat in the popliteal space may be quite pronounced and not only has the appearance of a cystic swelling, but on palpation suggests it. In two patients such a fat pad was found at operation and in one instance proved to be a definite lipoma. Incidentally, it is of interest to note that following the removal of this fat tissue the swelling of the lower leg and foot, which was previously present, entirely disappeared.

FIG. 6

The sac has been dissected free except for the pedicle which communicates with the knee joint. Note the cut surface of the gastrocnemius from which the sac was cut.

One patient with what proved to be a fibrosarcoma of the popliteal space was originally considered as a possible member of this group of cases, but, on palpation, the swelling was definitely hard and tender, in contrast to the cystic character and relatively painless tumor of the hernial sac. Aneurysm of the popliteal artery, so frequently noted in earlier reports, is not now often encountered.

At operation, a mid-line incision is made over the popliteal space and the site of the swelling. The lower end of the incision is directed toward

FIG. 7
Hernial sac removed in Case 9.

the medial or lateral side, depending on the location of the sac. Following division of the deep fascia, blunt dissection reveals the fibroserous wall of the sac (Fig. 5) which is then freed by sharp dissection, beginning at the more distal portion. It is always necessary to excise a part of the tendinous fibers of the gastrocnemius muscle (Fig. 6), because the wall of the hernial sac is so adherent that attempting to dissect it free results in rupture of the wall.

The popliteal nerve and, in the deep dissections of this space, the popliteal vessels are displaced to the lateral side of the leg to permit delivery of the sac, identification of its pedicle, and the point of communication with the joint space (Figs. 5 and 6). Once the sac is entirely free (Fig. 7), the pedicle is clamped and cut. The stump is then inverted into the joint space, and the foramen in the capsule is closed with heavy silk mattress sutures (Fig. 8). Tight closure of the foramen in the knee-joint capsule is an important step in preventing recurrence of the hernia.*

The wound is sutured in layers, special care being taken to approximate the edges of the deep fascia. A posterior plaster splint (Fig. 9) is then applied from the gluteal fold to the ankle, with the knee joint in full extension. This splint is worn for ten days to prevent scar formation, due to healing of the wound, from occurring with the knee in the flexed position. During this interval, the patient actively contracts the quadriceps muscle repeatedly.

During the immediately postoperative period, the knee is distended with fluid, sometimes to a marked extent, a reaction similar to that which occurs following removal of a meniscus. This fluid is gradually absorbed, or, if it persists, can be aspirated. It is believed that this degree of reaction is chiefly the result of a disturbance of the dynamics of the fluid in the knee joint.

After the splint is discarded, more active muscle exercise is instituted, again with particular attention to the function of the quadriceps muscle. Early weight-bearing with crutches is encouraged.

During the past four years twelve patients have submitted to operation for cystic swelling of the popliteal space. In nine knees a posterior hernia of the joint was demonstrated. In one case the cystic swelling was caused by enlargement of the semimembranosus bursa. In another case the swelling was a lipoma, and in the remaining patient there was a diffuse

* Geoffrey Jefferson observed recurrence of the cystic swelling in a child, six years old, whom he saw two months after operation elsewhere.

swelling over the popliteal region, due to hyperplasia of the subcutaneous fat pad. The average duration of symptoms in this group of patients was four years: the longest period was ten years; the shortest, six months. Eight of the patients were female and four were male. The youngest was a girl of ten; the oldest, a man of sixty-two years. Bilateral posterior hernia or enlarged bursa of the knee joint was not observed.

All of the patients in this group sought relief for generalized aching, and at times severe, sharp, "binding" pains in the knee joint, occasionally associated with intermittent effusion into the joint cavity. Ten patients described recurrent swelling of the lower leg and foot. In the course of observation in three cases it was found that, when the effusion into the knee joint was marked, the swelling in the

FIG. 8

The pedicle of the hernial sac is clamped and cut. With sufficient tissue in the stump, it is then inverted into the joint space, and the foramen in the capsule is closed with silk mattress sutures.

FIG. 9

After the operative wound is dressed, a posterior plaster splint, extending from the gluteal fold to the ankle, is applied with the knee joint in full extension.

popliteal space became much less pronounced. In one instance the popliteal swelling entirely disappeared, apparently the result of a sudden discharge of the contents of the hernial sac into the knee-joint cavity. One other patient said that when he had first noted something the matter with his knee it apparently contained fluid. At a somewhat later date this suddenly disappeared and the swelling in the popliteal space then appeared. In three instances the fluid in the knee joint remained for a period of time and was eventually absorbed, and then the cycle was repeated.

The frequency with which this interchange of synovial fluid between the hernial sac and the knee joint occurs apparently depends on the particular mechanics of the opening communicating between the two regions,—that is, if the pedicle of the hernial sac becomes twisted or crushed upon itself, or unduly thickened so that the lumen is blocked, then the popliteal swelling is consistently present. If the lumen of the pedicle is patent, fluid moves from one space into the other, depending on the activities of the individual, and especially appears to be affected by long periods of standing with the knee joint fully extended. This latter position tends to compress the hernial sac and to force the contained fluid into the knee joint. In every case in which operation was performed, however, the foramen between the joint cavity and the hernial sac was patent, although in some instances there was marked fibrosis of the pedicle of the sac with a narrow lumen. Four patients had never noticed fluid in the knee joint proper. On the other hand, with two exceptions, none of the group had observed a swelling in the popliteal space.

The roentgenograms of these knee joints consistently did not reveal any abnormality except in the older patients in whom some slight degenerative changes were found. The latter probably had in some measure been increased because of the irritative reaction set up by the interchange of fluid between the hernial sac and the joint, but in no instance were these changes marked.

Seven patients obtained relatively rapid increase of motion in the knee, so that within three weeks after operation normal flexion and extension without swelling of the joint were present, as well as adequate function of the muscles of the lower extremity. In two instances the interval was longer,—one patient required four weeks and the other six weeks to obtain full motion. This delay was due to the long duration of symptoms and to the seriously compromised function of the quadriceps muscle before operation, together with the fact that neither of these two individuals was very robust or active.

The longest follow-up in this series is four years; the shortest, eight months. In each of the patients the extremity is now normal and measures the same as the non-operated leg. None of the patients has experienced any further symptoms in the knee joint.

SUMMARY

In the presence of posterior hernia of the knee joint the patient's symptoms suggest an internal derangement of the knee. This condition

may be suspected when a cystic swelling is found in the popliteal space, particularly if located in the mid-line and, in greater part, distal to the skin-flexion crease in this region.

Clinically, the chief symptoms vary from aching discomfort to severe, binding pain in the knee region, often associated with intermittent effusion into the knee joint. There is a moderate to marked degree of disability.

The hernial sac communicates with the knee joint usually by a pedicle, one to two centimeters in length, arising either above or below the oblique popliteal ligament. The sac may occasionally dissect its way distally to the mid-calf region, lying on top of the gastrocnemius muscle and beneath the deep fascia.

On histological examination, the lining of the hernial sac is found to be a true mesothelium which cannot be distinguished from the synovial membrane of the knee joint. There is acute and chronic inflammation of the serosa, as well as round-cell infiltration of the subserous layers.

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FLANGE OSTEOTOMY FOR THE CORRECTION OF KNEES ANKYLOSED IN FLEXION

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By osteotomy and a wedging turnbuckle plaster encasement, a knee ankylosed in flexion can be straightened without injury to the circulation or to the innervation of the distal fragment. The truth of this proposition has been demonstrated by Whitman. It is the author's purpose to show that, by the location of the pivot of motion, such an extremity may be shortened, or its original length may be maintained or increased by osteotomy, and to present a new technique of correction by flange osteotomy.

In order to show the effect of the location of the pivot on the length of the straightened extremity, tracings of lateral roentgenograms of a normal child's knee in right-angled flexion and in extension have been made. By using the tracing of the knee in right-angled flexion as a model, various corrections have been made and the resulting length has been compared with that of the knee in extension.

Figure 1 demonstrates that the ordinary wedge osteotomy shortens the extremity in comparison with its original length, that a wedge osteotomy with a pivot at the approximate center of motion of a knee maintains the original length, and that an anterior wedge osteotomy may lengthen the extremity.

The mechanism of these relationships can be visualized by a study of Figure 2. It is obvious by counting the squares that a pivot located at *O* on the line *OA* gives the greatest shortening, and that the further toward *A* on the line *OA* the pivot is moved, the longer becomes the straightened extremity. Furthermore, an extremity straightened with a pivot on one point on the line *X* will be equal in length to an extremity straightened with a pivot on any other point on the line *X*. The same can be said for lines *Y* and *Z*. Thus, a supracondylar osteotomy could be performed at *N* with the same effect in length as if it were performed at *M*. In other words, a study of this diagram shows that the length of the straightened extremity will be equal to the long axis of the proximal fragment plus the long axis of the distal fragment, both axes being projected from the actual pivotal point of the osteotomy.

A flange osteotomy is simply an anterior wedge osteotomy constructed with a flange to aid in preventing posterior displacement of the distal fragment in the process of gradual extension. Figure 3 shows the construction of an anterior wedge *AOB* with *O* as the pivot and a line *OA* perpendicular to the long axis of the tibia and the line *OB* perpendicular, or slightly less than perpendicular, to the long axis of the femur, depending on whether the desire is to have the corrected extremity straight or

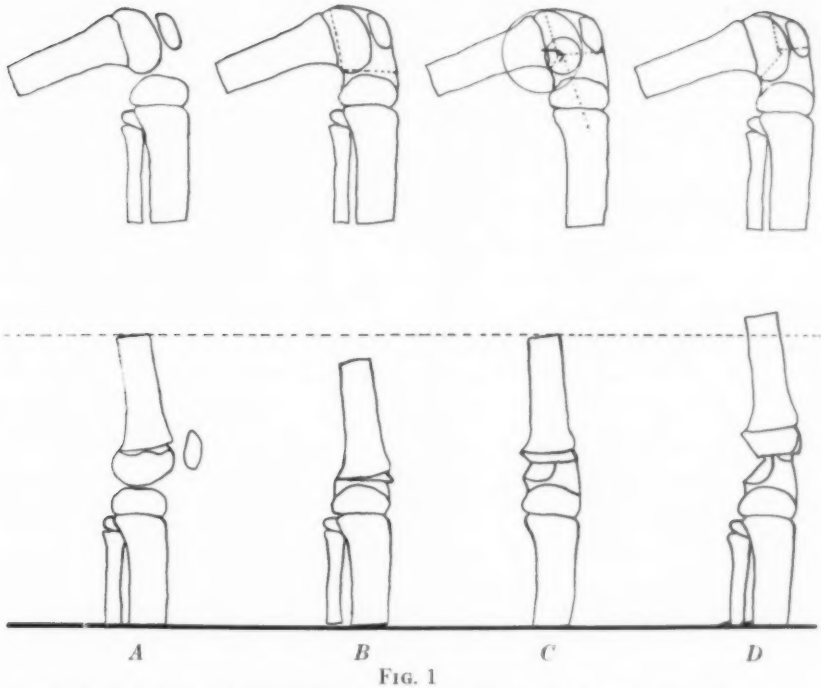

FIG. 1

A: Outline of the roentgenograms of a child's knee in flexion and in extension.
B: Outline of a regular wedge osteotomy showing the shortening that occurs in correction.
C: Outline of an osteotomy with the pivot at the approximate center of motion of the knee, showing that in the corrected position the original length is maintained. The upper diagram also shows that the posteriorly slanted section of the tibia is a function of a small radius of hinged knee-joint motion.
D: Outline of an anterior wedge osteotomy showing that the length of the corrected leg is longer than the original extremity.

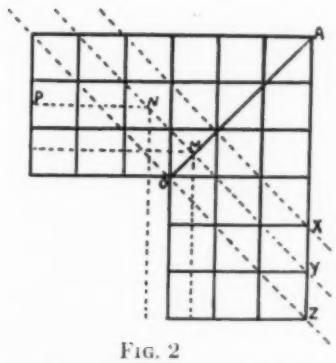

FIG. 2

A diagram visualizing the effect of the location of the pivot of an osteotomy in relation to the length of the corrected extremity.

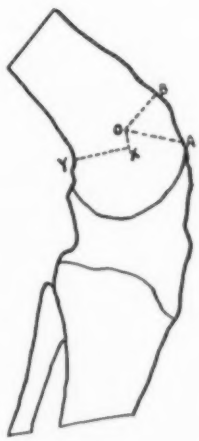

FIG. 3

Outline of a flange osteotomy.

FIG. 4

Flange osteotomy with the fragments in partial correction.

slightly flexed. Then a flange is outlined so that the angle OXY is approximately a right angle and the line XY is the shortest distance from X to the posterior border of the knee. This short line XY should be chosen in order to minimize posterior projection of the corners N and M (Fig. 4) in the extended position. It is apparent that this flange tends to prevent a backward luxation of the distal fragment in the process of gradual extension. When the flexion deformity is not too great, an extracapsular supracondylar flange osteotomy may be performed without greatly offsetting the long axis of the femur on the tibia. The supracondylar section is technically easy to perform and avoids the lower femoral epiphysis. The following case is illustrative.

CASE REPORT

B. E., a white girl, twelve years of age, was admitted to the hospital on October 11, 1934, complaining of a deformity of the left knee. The trouble had started eight years previously when the patient had been treated in a New York hospital for tuberculosis of the knee.

Examination showed the knee ankylosed in flexion and carrying scars from previous operations. A diagnosis of old tuberculosis of the knee with flexion deformity was made, and an osteotomy was recommended.

On November 2, 1934, under tourniquet, a lateral incision about four inches long was made over the outer aspect of the lower third of the femur. The quadriceps femoris and the tensor fasciae latae were retracted and the vastus lateralis was split anterior to

FIG. 5

B. E. Before operation.

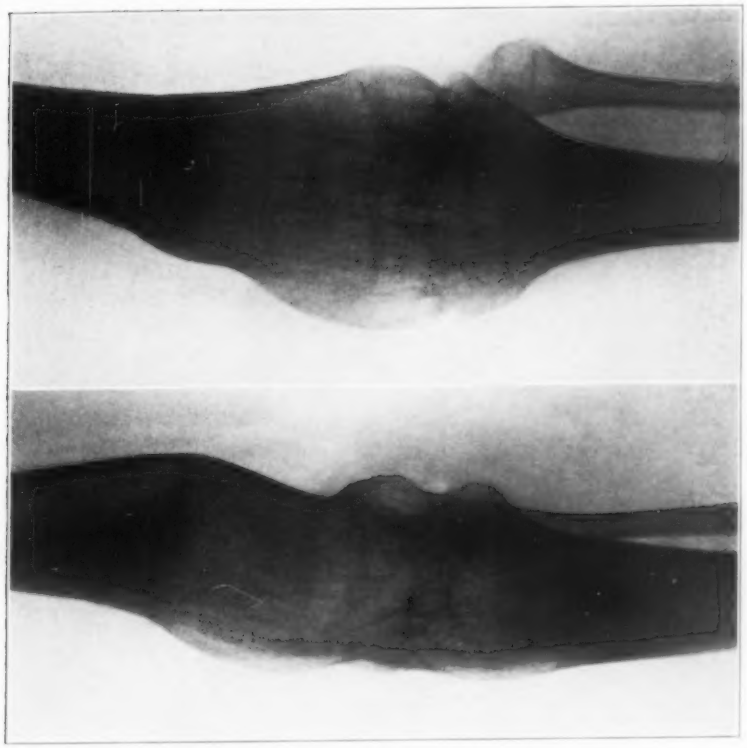

FIG. 7

B. E. End result approximately two years after operation.

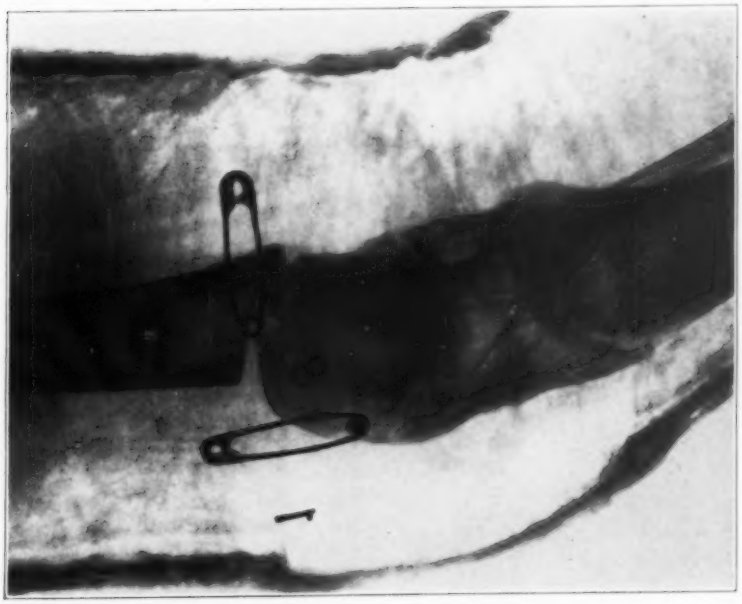

FIG. 6

B. E. Knee in the final position after removal of the turnbuckle.

the tensor fasciae latae, exposing the shaft of the femur. The periosteum was incised and elevated. The femoral shaft was drilled twice transversely with a quarter-inch drill, making drill holes one-half an inch apart and parallel to the long axis of the femur in the anterior half of the shaft (Fig. 3, points *O* and *X*). These drill holes were joined with an osteotome. With a saw, on the dorsal surface of the femur slanted from above downward, a wedgelike cut was made to join the superior drill hole (Fig. 3, line *BO*). With a Gigli saw passed beneath the femur, a section was made transversely to join the distal drill hole (Fig. 3, line *YX*). With an osteotome, an anterior wedge (Fig. 3, line *AOB*) was removed, using the superior drill hole as the axis until full correction of the deformity was obtained. The wound was sutured in layers. A plaster spica was applied with the flexion corrected to allow a strong pulsation of the popliteal artery.

On November 10, 1934, hinges were inserted into the cast and further correction was started. On November 17, the deformity had been completely overcome, and, on November 24, the turnbuckles were removed and plaster was applied to maintain the corrected position. One month later the fragments felt strongly united, but splintage was maintained until March 27, when walking without support was instituted.

Final roentgenograms (Fig. 7) were made on February 10, 1937, which show the end result of this operative procedure.

REFERENCE

WHITMAN, ARMITAGE: A New Method of Osteotomy for the Correction of Long Standing Bony Deformity at the Knee. J. Bone and Joint Surg., XVI, 155, Jan. 1934.

THE TREATMENT OF SLIPPING OF THE UPPER FEMORAL EPIPHYSIS WITH MINIMAL DISPLACEMENT *

BY PHILIP D. WILSON, M.D., NEW YORK, N. Y.

The subject of slipping of the upper femoral epiphysis is so large that the author proposes to confine this paper to a discussion of the following points:

1. The treatment of early stages of slipping.
2. The effect of operative fusion of the upper femoral epiphysis upon growth of the lower extremity.

THE TREATMENT OF THE EARLY STAGES OF SLIPPING

It is trite to remark that the best time to treat a disease is from the beginning, but this statement is so true of slipping of the upper femoral epiphysis that it needs to be emphasized. The earliest stages of slipping almost always give rise to symptoms which, if the physician is alert, can be recognized and will lead to the correct diagnosis. Given a patient between the ages of ten and sixteen years, complaining of intermittent pain and stiffness in the knee or thigh with at times a noticeable limp, one should consider slipping of the epiphysis as one of the first possibilities. Nor should one be led astray by the frequent localization of pain at the inner side of the knee into making only a local examination of that part; a thorough examination of the entire extremity should be made. Guarding or limitation of motions of internal rotation and of abduction of the hip are characteristic of epiphyseal slipping and can be demonstrated almost invariably. Shortening of slight amount may or may not be present, but it is not essential for a diagnosis. Since approximately 70 per cent. of the patients are overweight, the association of these symptoms with obesity in childhood should especially lead one to suspect the condition.

Suspicion of a pathological lesion of the hip will lead to a roentgenographic examination, and an accurate diagnosis can then be made. The irregular rarefaction of the metaphyseal zone of the neck in immediate contact with the epiphyseal cartilage, giving a characteristic appearance of widening of the epiphyseal line, is always evident, especially upon comparison with the normal hip. This may or may not be associated with evidence of displacement as shown by a change in the relationship of the epiphysis to the neck.

The diagnosis of slipping of the upper femoral epiphysis at an early stage, when the displacement is still minimal and not sufficient to cause any permanent functional impairment, permits an entirely different type of treatment from that which is necessary when serious deformity is present. An operation to realign the epiphysis may be avoided, and the

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outlook for complete functional restoration is infinitely better. Since the physician who is usually first consulted by the patient is the general practitioner, and since so much depends upon his recognizing the condition in its earliest stage, we orthopaedic surgeons have a duty to see that he is made familiar with the pathological and clinical appearances of the disease and that adequate instruction on this subject is given to the students in our medical schools.

It is inaccurate to describe these cases of early slipping as "preslipping" or "without displacement". Real slipping occurs as soon as the epiphysis is loosened, and without slipping it is doubtful if there would be any symptoms. As was stated by Milch, the first step in the mechanism of displacement is anteversion of the neck in relation to the epiphysis, which produces the characteristic fixed external rotation of the extremity. Only later does the upward displacement of the neck take place, resulting in the typical deformity with the capital epiphysis lying posteriorly and inferiorly.

The difference, then, between a case of early slipping and one of severe displacement is merely the degree of deformity. Any attempt, therefore, to fix a boundary between the displacement that is of no serious functional significance and that which is must be purely arbitrary and approximate. In making a decision one should be guided, not only by the roentgenographic examination, but also by the clinical evidence. More information as to the amount of displacement is usually to be obtained from the lateral roentgenogram than from the films made in the anteroposterior plane. When in the anterior view the upper border of the epiphysis appears well above the upper surface of the neck and in the lateral view the epiphysis has not displaced posteriorly more than one-third of the diameter of the neck, then, the author believes, the deformity may be safely accepted.

The writer has followed a number of patients who showed this amount of displacement and has seen them recover normal function with the exception of a slight loss of internal rotation. Important information in respect to the amount of deformity can also be obtained from the clinical examination. When there is free abduction and not more than 10 degrees of fixed external rotation of the hip, no disability will result provided that any further slipping is prevented.

Having made a diagnosis of slipping of the upper femoral epiphysis, and having determined that the amount of displacement does not exceed the above limits, what is the best plan of treatment? In previous communications by Waldenström, Ferguson and Howorth, and the author, it was pointed out that sound healing was not obtained until the epiphysis was fused to the neck and the epiphyseal cartilage became obliterated. The method of treatment which will most surely and rapidly accomplish this result, without risk of further displacement, is, therefore, the one to be preferred. The writer has made a thorough trial of weight-bearing caliper braces and ambulatory plaster spicas as protective devices and has rejected them as inefficient and dangerous. He has seen complete dis-

placement of the epiphysis occur in patients who were being treated by these methods. Recumbent treatment in a plaster spica is open to criticism on the grounds of uncertainty. It must be continued until epiphyseal fusion is obtained, and this may be a year or more. The author has seen recurrence of symptoms in a patient eleven months after immobilization in plaster was begun. Long-continued fixation is also harmful because of the ensuing atrophy. Waldenström and Wardle favor the use of continuous extension, but the former expects that such treatment may have to be prolonged for as much as a year in order to obtain healing.

There remain to be considered various methods that aim at obtaining early fusion of the epiphysis. Jahss proposed hammering on the lateral aspect of the trochanter to traumatize the epiphysis, followed by the application of a plaster spica, and reported good results from this treatment. The author distrusts the use of a method whose force cannot be accurately controlled, and feels that it is unlikely that uniform results can be obtained. Ferguson and Howorth advocated drilling through the epiphyseal plate and the insertion of small sliver bone grafts. Their method requires arthrotomy and seems unnecessarily complicated. Multiple drilling through the neck from the trochanter has been done by Bazin and others, but this does not seem an entirely easy or hazardless procedure, and it does not obtain fixation of the epiphysis.

In a previous communication the writer described an operative realignment of the displaced upper femoral epiphysis with fixation by the Smith-Petersen nail. This procedure requires arthrotomy of the hip and is only justifiable in cases with severe displacement. As methods were devised for the fixation of fractures of the femoral neck by the insertion of nails or pins through the trochanter under roentgenographic control without arthrotomy, it was natural to make use of this technique in the treatment of early slipping of the upper femoral epiphysis. The first patient to be treated by this method was operated upon by the author in October 1934, and since that time a total of nine patients have been subjected to the procedure. It has proved admirable for its purpose, and complete functional restoration has been obtained in those cases where the amount of posterior displacement of the epiphysis did not exceed the limit of acceptable deformity as previously explained.

The writer employed the Smith-Petersen nail as the instrument of internal fixation and made use of Wescott's technique for introducing it. Reduction was not attempted. Under general anaesthesia an incision was made over the lateral aspect of the trochanter, and the nail was started at a point about one inch below the ridge for the insertion of the vastus lateralis. The leg was held by an assistant, with the hip internally rotated as much as possible, and the nail was driven home at the angle and to the depth previously determined from measurement of the roentgenograms of the hip. The direction of the nail was controlled by roentgenographic examination in both the anteroposterior and lateral planes during the course of the operation. On the whole, the procedure is

simple, although, because of the posterior displacement of the head, there is more need for accurate roentgenographic control in the lateral plane than in the case of a fractured femoral neck.

After closure of the wound and the application of a firm dressing, the patient was returned to bed without any external splinting. The postoperative discomfort was slight and the patient was allowed to be up at the end of one week. The author does not know how soon these patients may be permitted to bear full weight on their hips and he has erred on the side of safety. They were required to walk with crutches and a raised shoe on the sound side until the end of eight weeks. After this period full activities were permitted, with the exception of rough sports.

The use of the nail in these cases serves two purposes. It fixes the epiphysis and thus prevents any possibility of further displacement; and it also penetrates the cartilaginous plate and allows the ingrowth of reparative elements, thus promoting healing and early fusion of the epiphysis. Study of the progress of the healing by roentgenographic observation shows that obliteration of the epiphyseal cartilage is usually obtained in from four to six months. Later removal of the nail seems advisable, although there has been no evidence that any irritation was caused by it. The writer has made a practice of doing this usually at the end of about nine to twelve months. This is a simple operation, not involving a lay-up of more than a few days, which, nevertheless, constitutes the chief disadvantage of the method. The simplicity and security of the procedure, together with its avoidance of postoperative splinting and its great saving of time for the patient, are such positive advantages that they far outweigh this one objection.

Two points should always be remembered in the treatment of patients with early slipping of the upper femoral epiphysis. The first is that the patient's condition should be considered as urgent from the mo-

TABLE I

MEASUREMENTS OF SHORTENING OF LEGS IN PATIENTS WHOSE EPIPHYSES WERE NAILED

Case No.	Name	Sex	Involvement	Age at First Operation (*Years*)	Preoperative Shortening (*Inches*)	Shortening at Last Measurement (*Inches*)	Postoperative Period (*Months*)
1	A. M.	Male	Unilateral	12	½	½	34
2	D. W.	Female	Bilateral	12	½	½	31
3	W. Y.	Female	Unilateral	12	0	1	27
4	G. W.	Female	Bilateral	10 8/12	0	0	18
5	D. F.	Male	Unilateral	16	½	0	16
6	H. P.	Male	Unilateral	12 7/12	¼	0	13
7	J. B.	Male	Unilateral	14 6/12	0	0	13
8	R. F.	Female	Unilateral	12 8/12	0	½	5
9	C. S.	Male	Unilateral	15 6/12	¼	¼	4

ment that the diagnosis is made or even suspected. The author can recall several instances where the physician did not insist upon immediate treatment and the patients returned home only to be brought back to the hospital a few days later by ambulance because a slight misstep or fall had resulted in a complete separation of the epiphysis. The outlook for the patient who is treated in the early slipping stage is so far superior to that of one with complete displacement that no risk of the former condition's being converted into the latter should be permitted. Until the epiphysis is nailed, the only safe place for the patient is in bed with extension to the leg, and any delay in instituting such treatment is dangerous.

The other point is that the possibility of bilateral involvement of the hips should be constantly kept in mind. The patient and his parents should be warned to report the slightest suspicious symptoms arising on the unaffected side, and, as an extra safeguard, both hips should be included in the roentgenographic examination as often as this is required. In this way slipping of the other epiphysis can be recognized and treated while still in a favorable stage.

THE EFFECT OF FUSION OF THE UPPER FEMORAL EPIPHYSIS UPON GROWTH OF THE LOWER EXTREMITY

One of the first questions that arose in connection with the treatment of slipping of the upper femoral epiphysis by the insertion of a nail or pin was: "What would be the effect of early fusion of this epiphysis upon the growth of the extremity?" Although at the time the author was unable to answer this question, he soon satisfied himself that it was largely academic, since the review of a series of roentgenograms of patients treated in plaster without operation showed that the epiphyseal cartilage fused early in any case. Subsequent follow-up examination of the patients whose hips were nailed was reassuring and showed that serious shortening of one extremity did not develop. The measurements of inequality in length prior to operation and at the last follow-up observation in the nine patients whose epiphyses were nailed are shown in Table I. It will be seen that four patients showed no shortening; one had shortening of one-quarter of an inch; three, of one-half an inch; and one, of one inch. Of the five patients with shortening, three showed the same amount as had existed before operation and only two with legs of equal length in the beginning showed later inequality. Two patients with slight inequality before operation made good the deficiency and later had legs of equal length. The greatest amount of shortening was one inch in one patient and this did not increase in the last eighteen months.

It is of interest to try to explain these rather surprising observations. Digby, in his studies of the growth of the long bones, gave the figures for the femur and the tibia shown in Table II.

While both Gray and Piersol give the time for the closing of the upper femoral epiphysis at about eighteen years, Cohn, whose conclusions were drawn from the study of a series of roentgenograms, fixed it at approxi-

TABLE II

GROWTH OF BONES OF LOWER EXTREMITY (DIGBY)

Epiphyseal Region	Amount of Growth	Percentage of Growth
Upper end of femur	5.0 inches	17.2
Lower end of femur	11.0 inches	37.8
Upper end of tibia	7.5 inches	25.8
Lower end of tibia	5.6 inches	19.2
Total	29.1 inches	100.0

mately fifteen years, and this is probably the more reliable figure. Since this epiphysis contributes approximately 17 per cent. of the total growth of the lower extremity, and since slipping of the upper femoral epiphysis occurs between the ages of ten and sixteen years with an average age of about thirteen years, one is forced to conclude that the absence of serious shortening is due either to a precocious closing of the corresponding epiphysis on the unaffected side or to the fact that most of the growth from the upper femoral epiphysis takes place early and diminishes to a small amount after the age of twelve years. While Cohn's studies support the latter hypothesis and this affords an adequate explanation in children belonging to the older age group, it does not seem sufficient in those of from ten to twelve years. The author's own observations show that closure of the unaffected epiphysis usually takes place within two years after the appearance of slipping, which is frequently considerably in advance of the normal time. Precocious closure of this epiphysis lends confirmation to the theory that epiphyseal slipping is the result of metabolic disorder.

Another question that has been raised in connection with early closure of the upper femoral epiphysis has to do with the effect of continued growth of the epiphysis for the greater trochanter upon the gradual reduction of the angle of the femoral neck. It was suggested that the trochanteric region of the femur would continue to grow and that with the capital epiphysis closed, resulting in a stationary position of the head, a gradual ascent of the greater trochanter would take place with the production of a coxa-vara deformity. The writer reviewed a series of late roentgenograms in a group of patients upon whom operative replacement of the epiphysis and nailing had been performed some time earlier and was inclined to agree that there was some confirmation of this theory. Acting upon this belief, in 1934 he fused the epiphysis for the greater trochanter in two patients at the same time that he nailed the capital epiphysis. (See Cases 1 and 3.) These patients have now been followed thirty-four and twenty-seven months respectively and, while they show no change in the angle of the neck with the shaft, neither do any of the other patients in whom nailing of the capital epiphysis alone was done. Therefore, the writer is unable to demonstrate in the period of time that has thus far

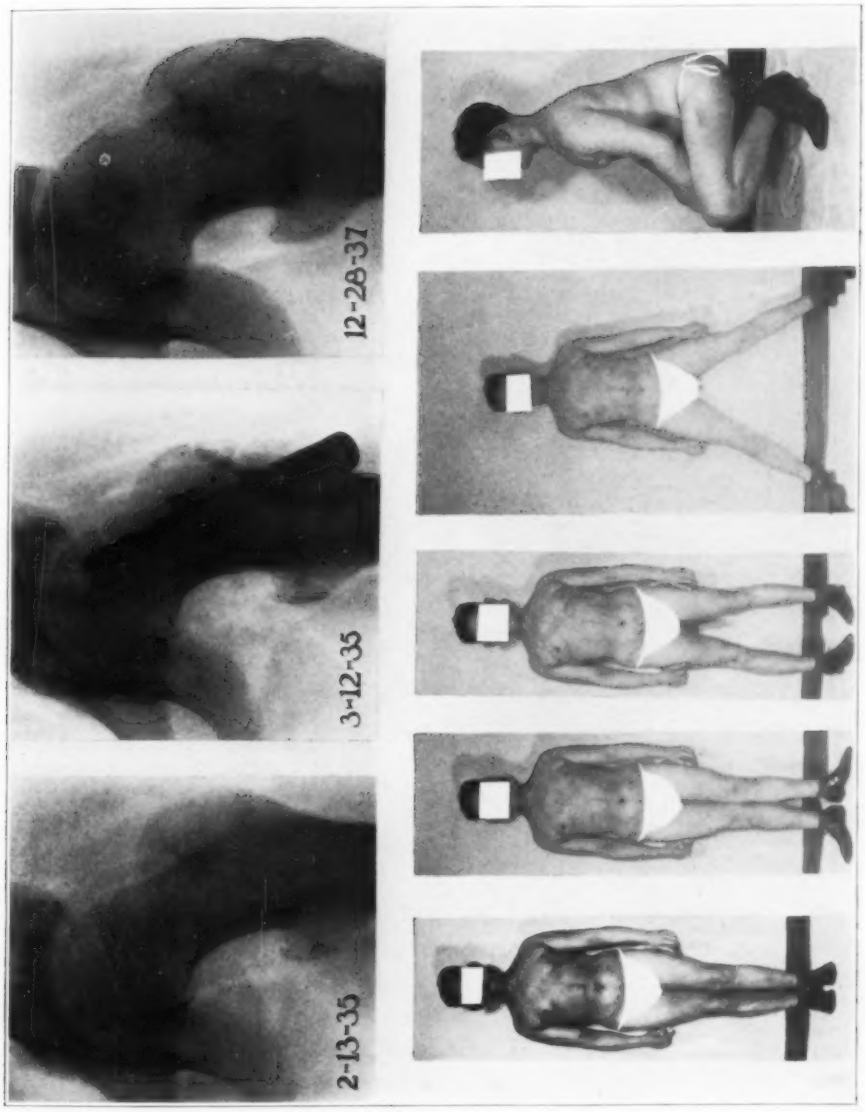

FIG. 1—Case 1.

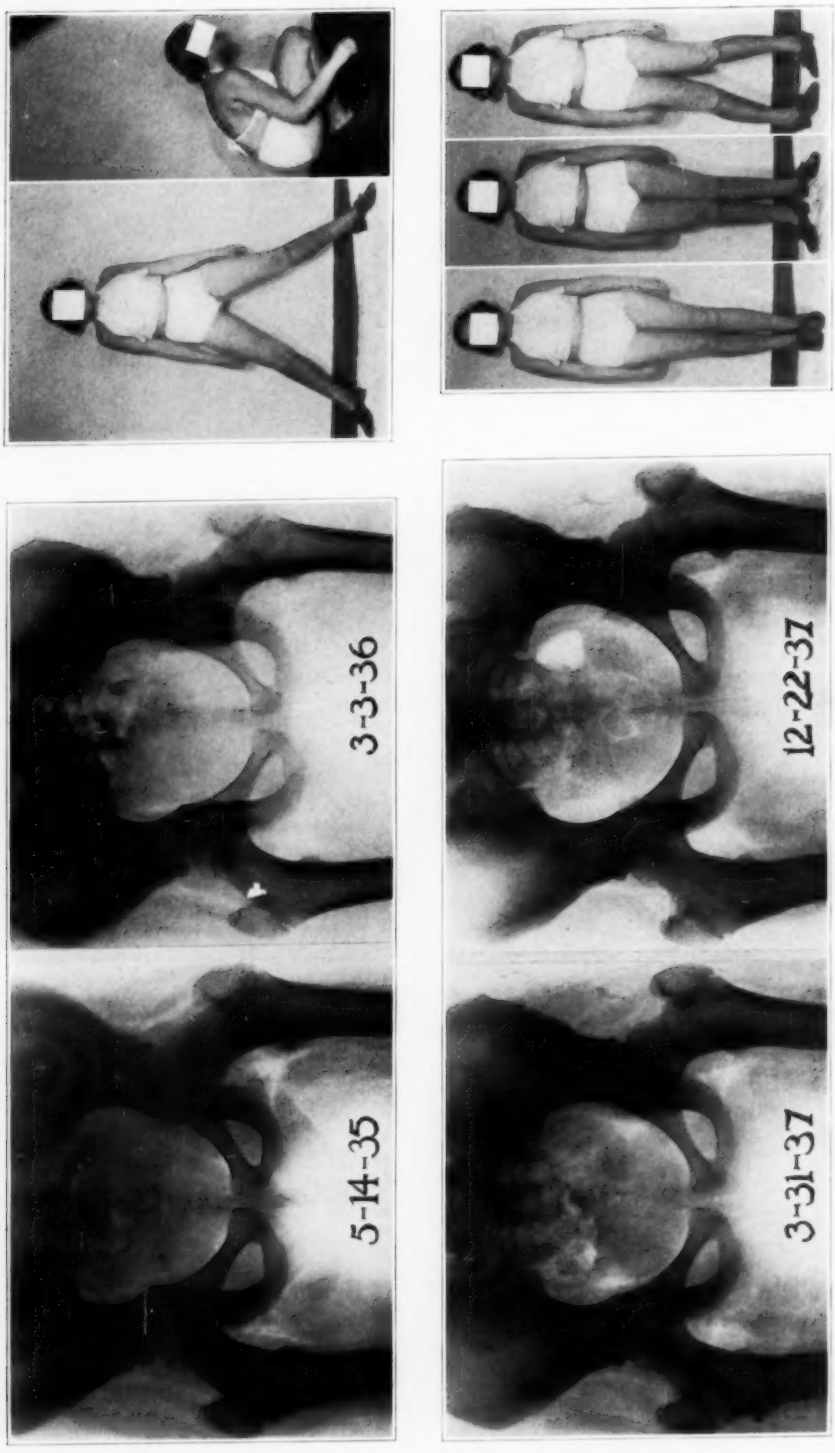

FIG. 2—Case 2.

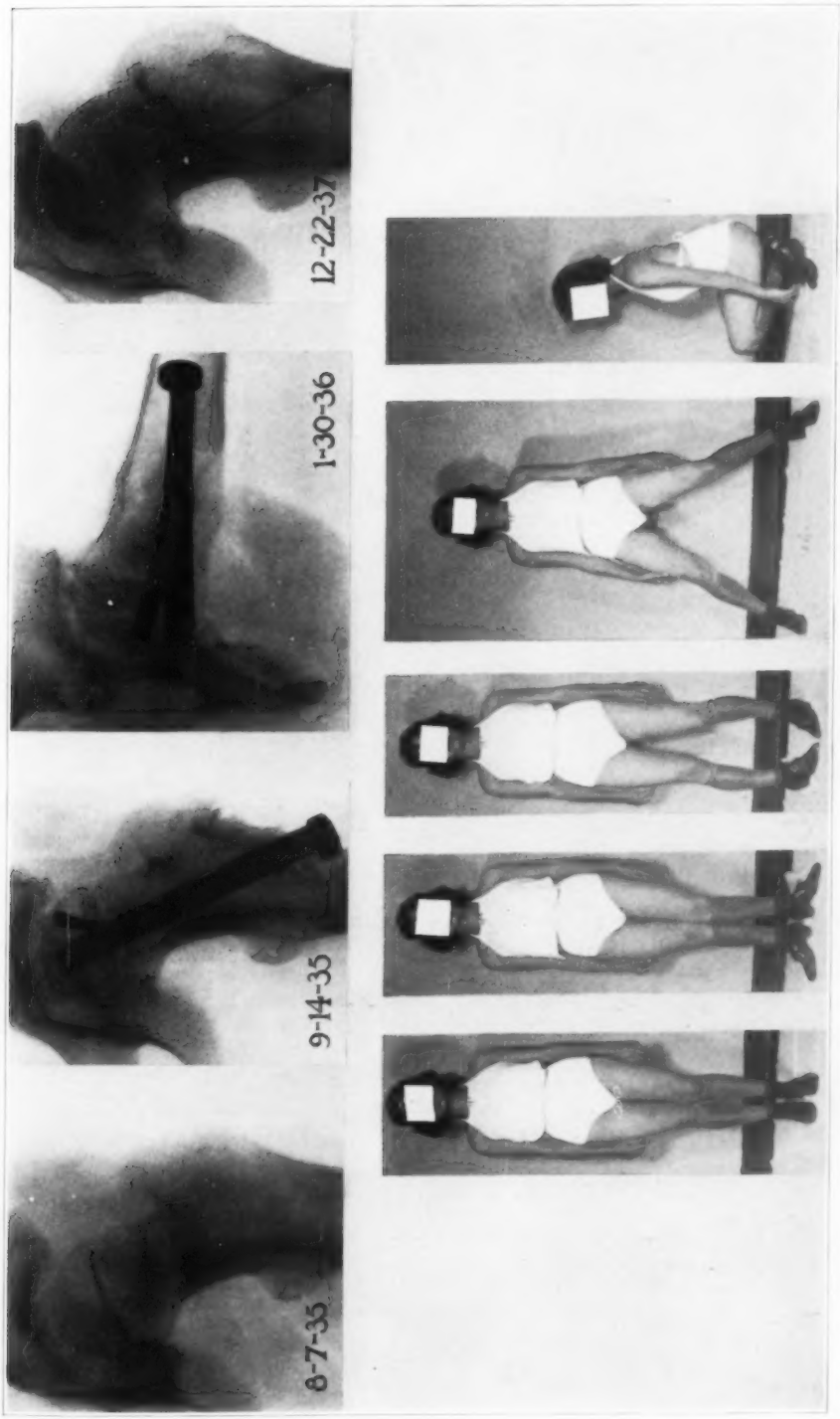

FIG. 3—CASE 3.

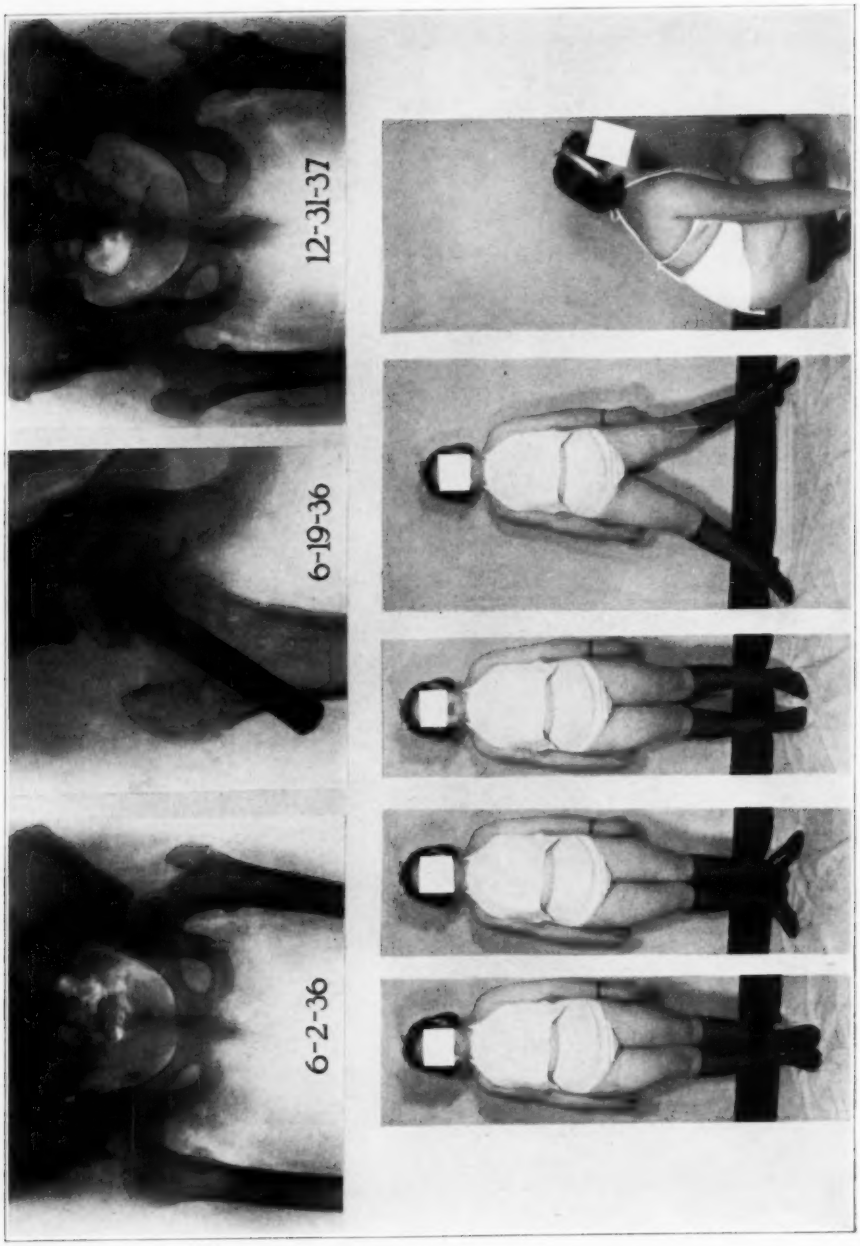

FIG. 4—Case 4.

elapsed that there is any advantage to the patient in this particular procedure.

CASE REPORTS

CASE 1 (H17–949). A. M., male, aged twelve, was admitted on February 11, 1935, with a history of a fall four months previously, followed by increasing pain in the left leg and a limp. Physical examination showed an obese boy of the "Fröhlich" type, with slight limitation of abduction and internal rotation of the left hip. There was one-half an inch of shortening of the left leg. Roentgenographic examination on February 13, 1935, showed widening of the epiphyseal line, but only slight displacement of the femoral head. A diagnosis of slipping of the upper femoral epiphysis was made and operation was advised.

On February 20, 1935, under general anaesthesia, an incision was made over the lateral aspect of the greater trochanter, and a Smith-Petersen nail was inserted following Wescott's technique. An epiphysiodesis of the trochanteric epiphysis was also done. The patient was kept in bed one month and was then permitted up with a one-inch lift on the right shoe and crutches, which he continued to use for four months. He then resumed full activities.

The nail was removed on October 11, 1935, eight months after insertion. When seen on December 22, 1937, thirty-four months after nailing, the patient had no complaints or disability. Examination showed no appreciable limitation of motion of the left hip. There was shortening of one-half an inch. The measurements were as follows:

	Left	*Right*
Length	34½ inches	35 inches
Abduction	45 degrees	35 degrees
External rotation	50 degrees	40 degrees
Internal rotation	15 degrees	20 degrees
Flexion	135 degrees	135 degrees
Extension	Normal	Normal

CASE 2 (H19–030). D. W., female, aged twelve, was admitted on May 20, 1935. The patient complained of pain in the left hip of five weeks' duration which began insidiously and without injury. Physical examination showed an overweight girl with a limp on the left side and limitation of internal rotation and of abduction of the left hip. There was one-half an inch of shortening of the left leg. Roentgenographic examination showed rarefaction at the epiphyseal line and slight posterior displacement of the femoral head.

On May 22, 1935, an operation was performed under ether anaesthesia. The epiphyseal cartilage was drilled in several places, and small sliver bone grafts were inserted in the drill holes. The patient made an uneventful recovery and was discharged on June 25, 1935. She walked with the aid of crutches until the end of eight weeks and then resumed full activities.

In March 1936, she began having stiffness and fatigue in the right lower extremity. There was a slight limp, but no restriction of motion and no shortening. Roentgenographic examination showed rarefaction along the line of the right capital epiphysis, but no demonstrable displacement. The left capital epiphysis was united.

She was readmitted to the hospital and, on March 21, 1936, an operation on the right hip was performed. A Smith-Petersen nail was inserted through a lateral incision over the trochanter under roentgenographic control. The patient was discharged, and walked with crutches for five weeks; she was then permitted full activities. She was readmitted to the hospital approximately one year later, and the nail was removed.

When examined on December 22, 1937, she complained of only an occasional "weather pain", but was conscious of no disability. There was one-half an inch of shortening of the left lower extremity. All motions of both hips were painless and free. Roent-

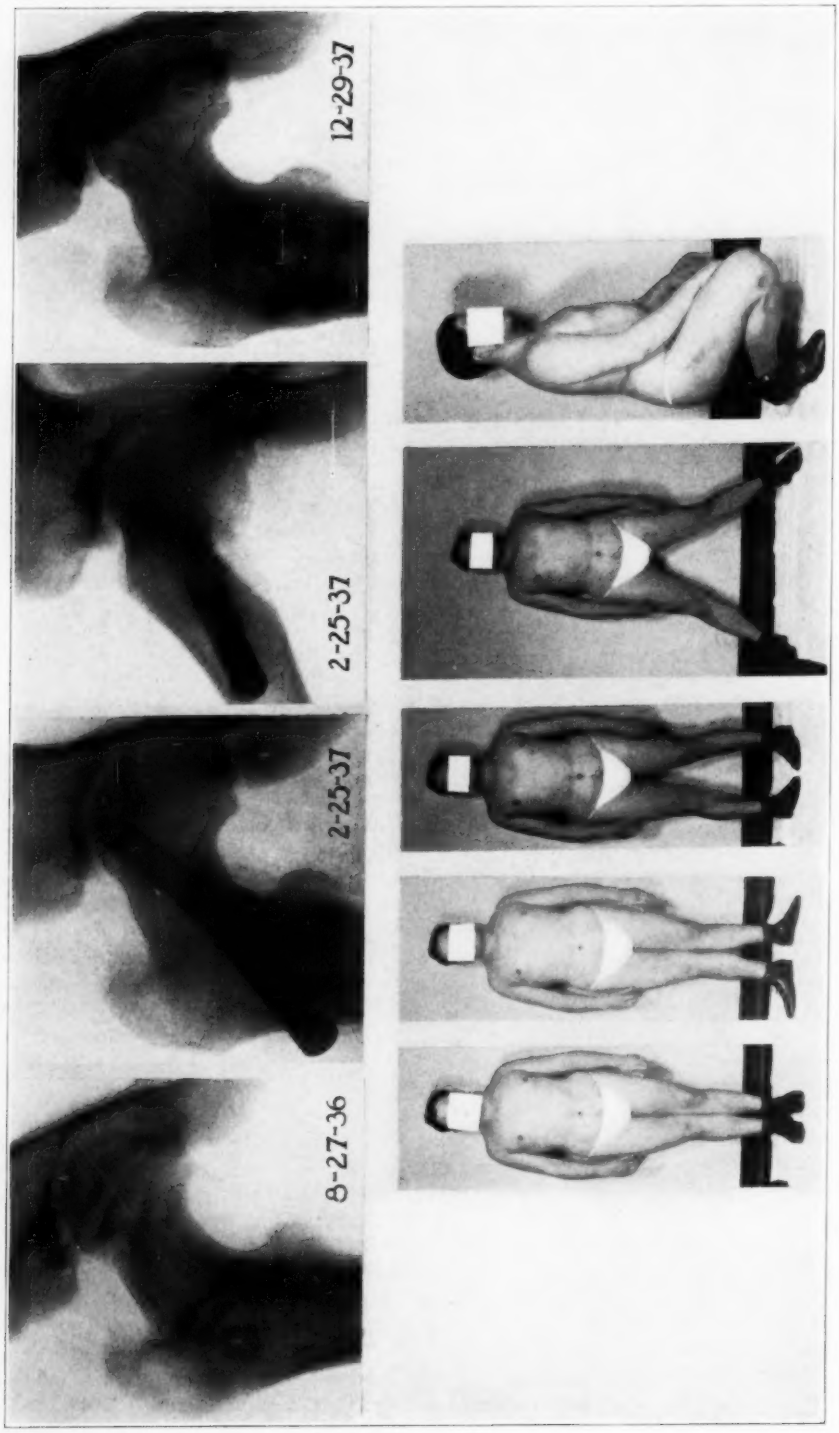

FIG. 5—Case 5.

genographic examination showed both capital epiphyses to be fused. The comparative measurements were as follows:

	Left	*Right*
Length	34½ inches	35 inches
Abduction	33 degrees	40 degrees
External rotation	55 degrees	35 degrees
Internal rotation	Normal	Normal
Flexion	Normal	Normal
Extension	Normal	Normal

CASE 3 (H14–917). W. Y., female, aged twelve, was admitted on August 12, 1935. The patient gave an indefinite history of a fall from a swing, followed by pain and limp of the left leg of six weeks' duration. Examination showed an obese girl in good physical condition. The left lower extremity was held in a position of external rotation and could not be internally rotated to beyond a neutral position. The leg length was equal. Other motions of the hip were free. Roentgenograms, taken on August 7, 1935, showed slight posterior displacement of the femoral head and widening of the zone of the epiphyseal cartilage.

On September 11, 1935, an operation, consisting of the insertion of a Smith-Petersen nail by Wescott's method, was performed, and an epiphysiodesis of the trochanteric epiphysis was done. The patient was kept in bed for three weeks and was then discharged on crutches. Weight-bearing was not permitted until the end of three months. Roentgenograms on September 14, 1935, and January 30, 1936, showed the nail in good position. The nail was extracted on June 24, 1936, nine and one-half months after insertion.

When last examined on December 22, 1937, twenty-seven months after nailing, the patient presented no complaint or disability. There was one inch of shortening of the extremity. The range of motion of the operated hip was entirely comparable with that of the normal hip, and there was normal musculature. The roentgenogram showed both capital epiphyses fused.

CASE 4 (H23–249). G. W., female, aged ten years and eight months, was admitted on June 1, 1936, complaining of pain in the right hip and lameness of about one year's duration. The onset was gradual without history of injury. Examination showed a short, obese girl walking with a marked right-sided limp. The right hip was held in fixed external rotation of 20 degrees and in slight adduction. All motions of the hip were limited and guarded. The leg length was equal. The roentgenographic examination showed moderate downward and marked posterior displacement of the capital epiphysis. Operative realignment was advised.

Operation was performed on June 3, 1936. The hip was exposed by a goblet-shaped incision, extending downward and laterally from the anterior superior spine and separating in the plane between the tensor fasciae femoris and the sartorius. The capital epiphysis was found lying posteriorly but firmly united to the neck. It was separated with a chisel without injuring the ligamentum teres. The neck was trimmed to fit accurately and was then replaced in normal relation to the head. A Smith-Petersen nail was driven up through the trochanter, solidly fixing the head. The wound was closed, and the patient was returned to bed with light adhesive extension to the leg. At the end of two weeks the extension was discontinued and active exercises were started, but without weight-bearing. The patient was allowed up on crutches with a raised sole on the opposite shoe. Mobility of the hip was rapidly recovered and the patient was discharged on July 15, 1936. Full weight-bearing was permitted at the end of three months, and she rapidly resumed normal activities.

She was readmitted to the hospital on July 19, 1937, for removal of the nail. At this time the roentgenographic examination showed solid fusion of the right femoral epiphysis, but widening of the epiphyseal-cartilage space in the left hip and evidence of beginning slipping. An operation was performed on July 21, 1937, under general anaes-

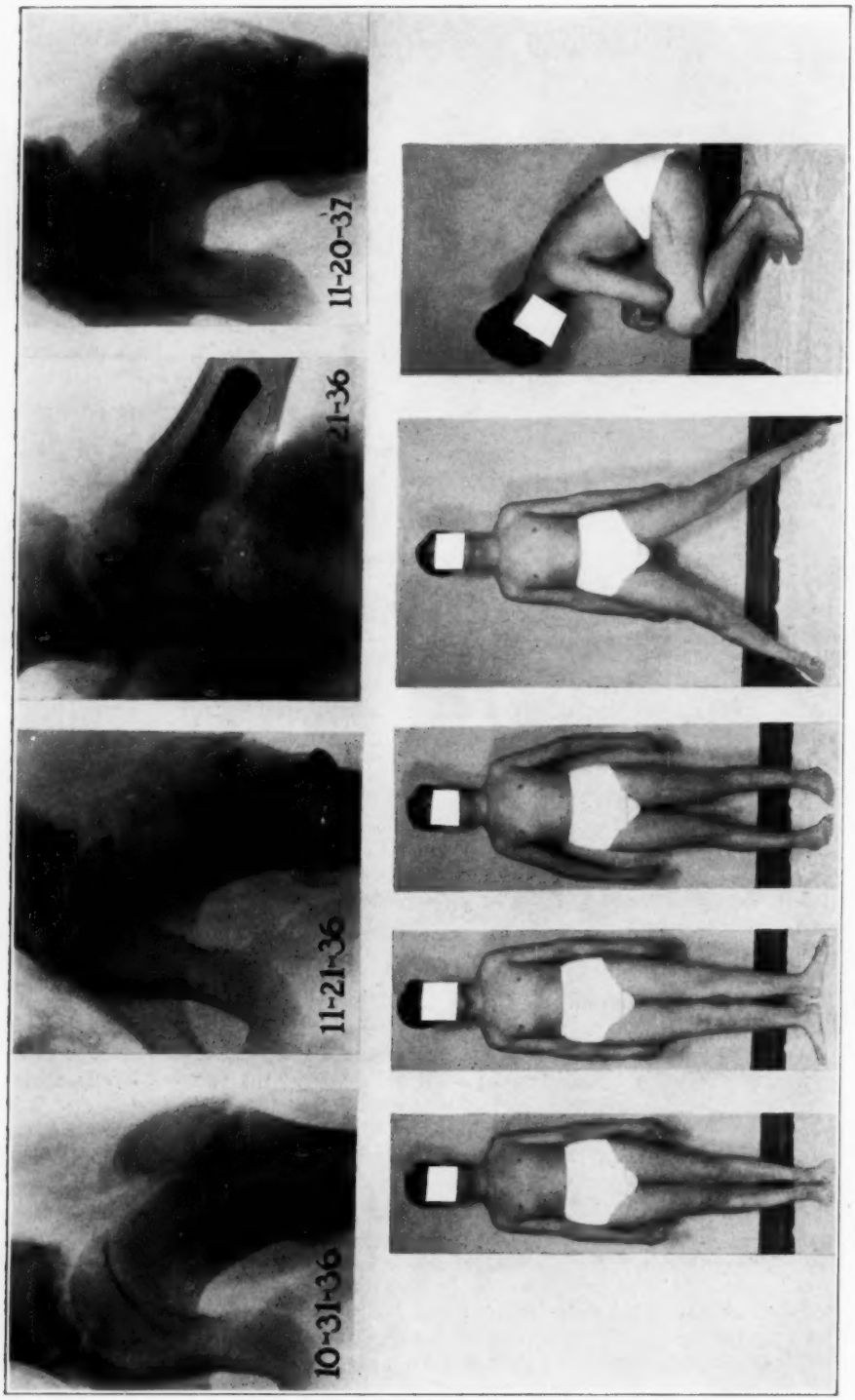

FIG. 6—Case 6.

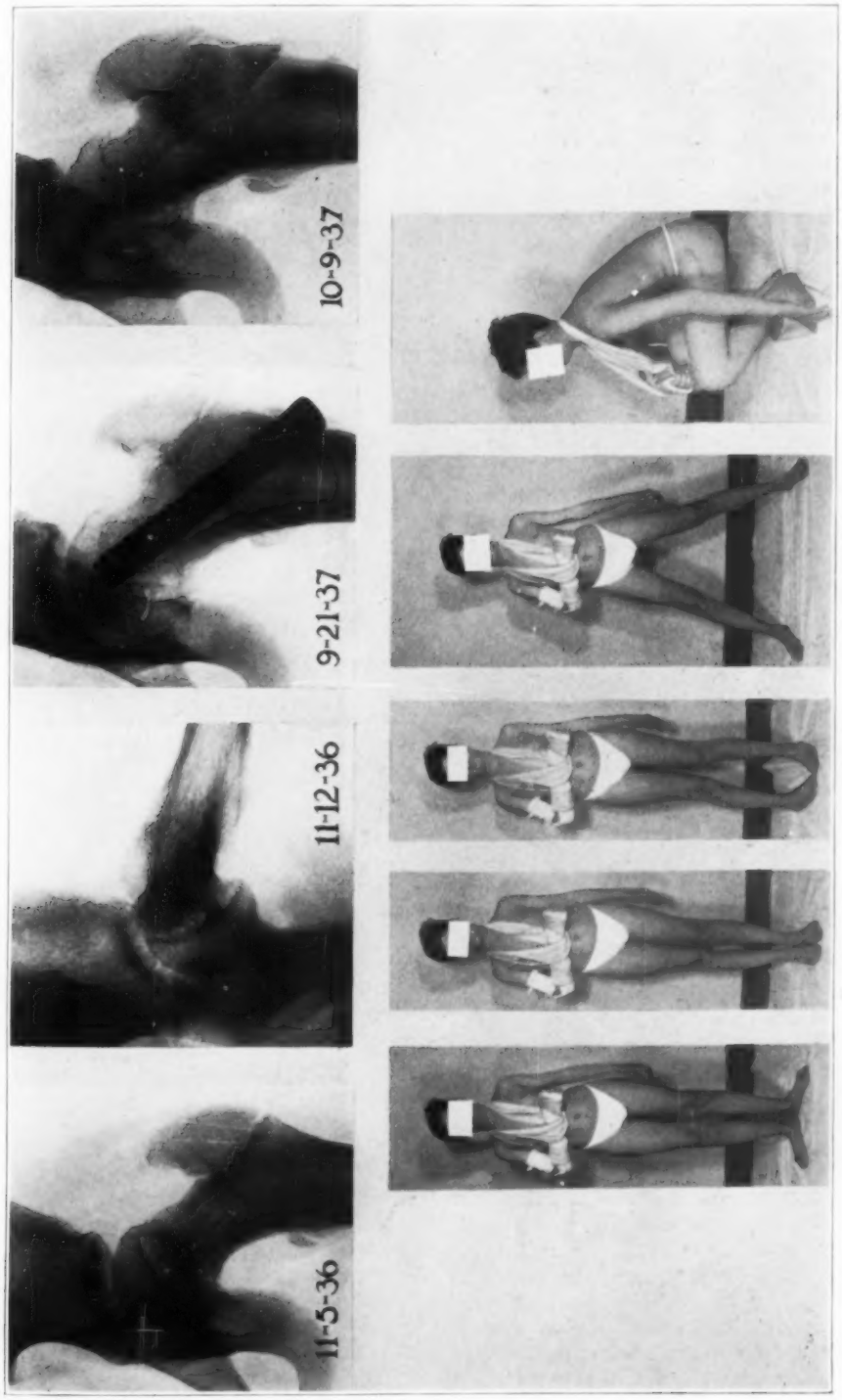

FIG. 7—Case 7.

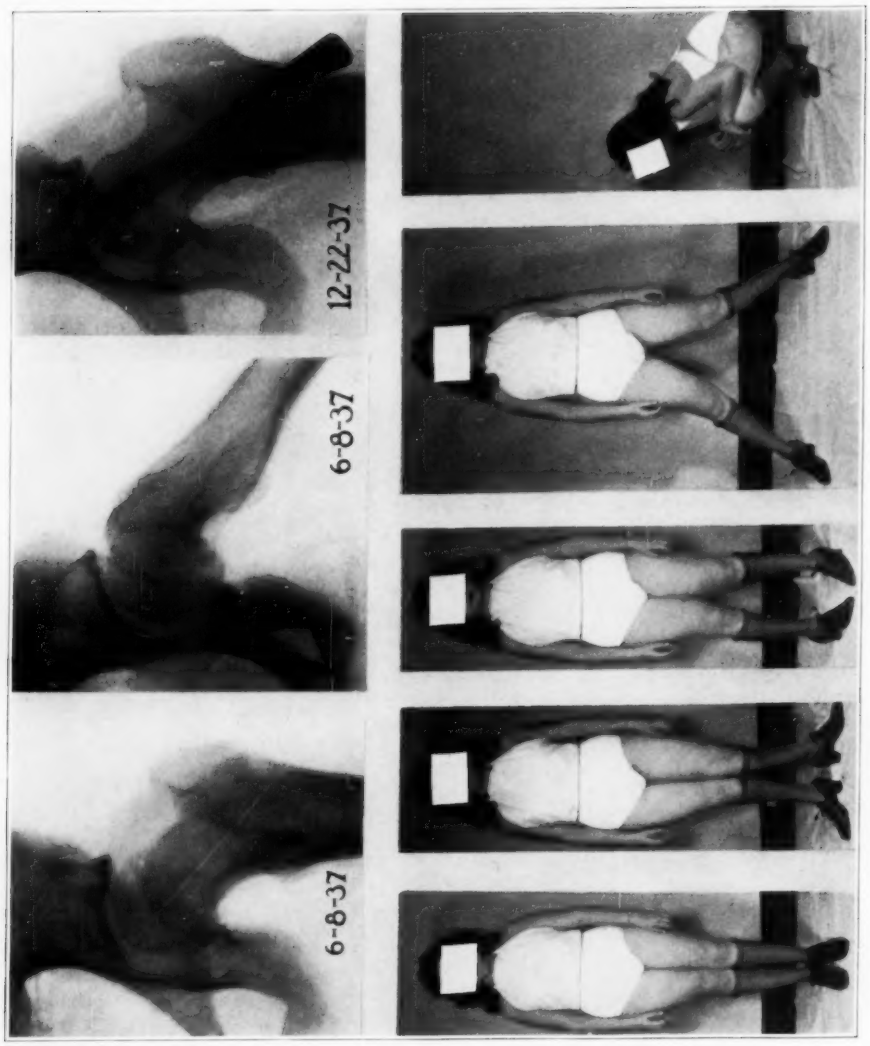

FIG. 8—Case 8.

thesia. Through a lateral incision over the left trochanter, a Smith-Petersen nail was inserted under roentgenographic guidance. A small incision was made over the right trochanter, and the nail on this side was removed. Full mobility of both hips was permitted immediately. The patient was discharged one week after operation, walking on crutches, and full weight-bearing was not allowed until the end of four months.

When last examined on December 31, 1937 (in the illustration the roentgenogram is shown reversed), she had full use of the legs and there was no complaint. The leg length was equal, and there was free and painless motion in both hips. The measurements were as follows:

	Left	*Right*
Length	31¼ inches	31¼ inches
Abduction	30 degrees	30 degrees
Adduction	20 degrees	20 degrees
External rotation	50 degrees	50 degrees
Internal rotation	10 degrees	30 degrees
Flexion	115 degrees	117 degrees
Extension	Normal	Normal

CASE 5 (H23–600). D. F., male, aged sixteen, was admitted on August 26, 1936. He gave a history of pain in the right hip of intermittent character for a period of two or three years, but continuous during the previous few months. There was no history of injury. Physical examination showed an obese boy walking with a definite right-sided limp. There was one-half an inch of shortening of the right lower extremity. The right hip was held in slight fixed external rotation, and there was slight limitation of abduction. The other motions were free. The roentgenographic examination revealed a slipped femoral epiphysis with moderate coxa-vara deformity.

An operation was performed on August 28, 1936, and a Smith-Petersen nail was inserted by the Wescott method. After two weeks of hospitalization, the patient was discharged walking on crutches. Full activities were resumed at the end of four months. The nail was removed on May 14, 1937, approximately nine months after insertion.

When last examined on December 22, 1937, sixteen months after nailing, the patient stated that he had participated actively in sports and was entirely well. There was no limp. The leg length was equal, and there was no significant limitation of motion. The roentgenogram showed union of the capital epiphysis and satisfactory position. The measurements were as follows:

	Left	*Right*
Length	34 inches	34 inches
Circumference of thighs	23¾ inches	23 inches
Abduction	50 degrees	35 degrees
External rotation	45 degrees	55 degrees
Internal rotation	10 degrees	5 degrees
Flexion	135 degrees	134 degrees
Extension	Normal	Normal

CASE 6 (H24–440). H. P., male, aged twelve years and seven months, was first seen on October 10, 1936, at which time he complained of pain in the lateral aspect of the left knee. Later pain developed in the region of the hip. Examination showed one-fourth of an inch of shortening of the left leg. There was slight restriction of internal rotation and of flexion. Hyperextension was increased. Roentgenographic examination showed early slipping of the left femoral epiphysis.

The patient was admitted to the hospital on November 16, 1936, and nailing through a lateral incision under roentgenographic control was performed on November 18, 1936. He was permitted up a few days later and was discharged on January 2, 1937, walking with a raised shoe on the right and crutches. Full weight-bearing was permitted at the end of two and one-half months, and the patient quickly recovered normal function. He was readmitted one year later and the nail was removed.

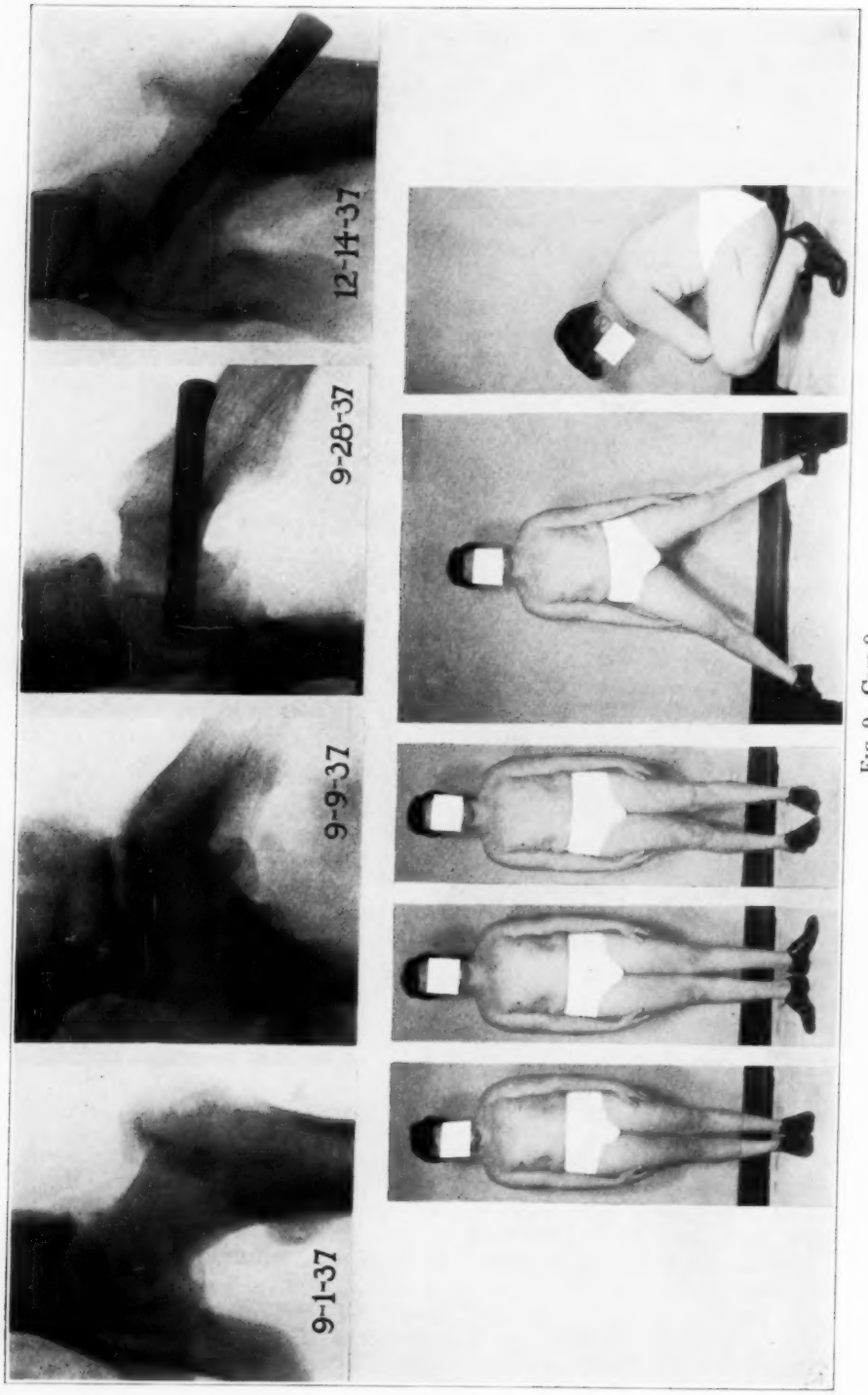

FIG. 9—Case 9.

When last examined on December 22, 1937, thirteen months after the first operation, he presented no complaints. There was a normal range of motion of the affected hip, and the lower extremities were of equal length. The roentgenogram showed fusion of the capital epiphysis. Comparative measurements of the hips were as follows:

	Left	*Right*
Length	34¾ inches	34¾ inches
Abduction	30 degrees	43 degrees
Adduction	Normal	Normal
External rotation	45 degrees	45 degrees
Internal rotation	20 degrees	30 degrees
Flexion	120 degrees	125 degrees

CASE 7 (H24–151). J. B., male, aged fourteen years and six months, was first examined in the Clinic on November 9, 1936. He gave a history of pain in the left hip of five weeks' duration, which had begun with a sudden click while walking. Examination showed a slender boy with a left-sided limp. Restriction and guarding of all movements of the left hip were noted. The leg length was equal. Roentgenographic examination showed widening of the epiphyseal line of the left hip with evidence of beginning slipping. The patient was admitted to the hospital immediately, and an operation was performed on November 13, 1936. A Smith-Petersen nail was introduced under roentgenographic guidance by the usual technique without any effort at reposition of the head. A one-inch lift was placed on the right shoe. The patient was permitted to walk with crutches and was discharged on December 10, 1936. He was allowed to walk normally at the end of two months. He was readmitted to the hospital thirteen months after operation, at which time there was fusion of the capital epiphysis, and the nail was removed.

Examination on December 7, 1937, showed normal function and no complaint. The leg length was equal. The comparative measurements of length and hip motion were as follows:

	Left	*Right*
Length	34½ inches	34½ inches
Abduction	42 degrees	43 degrees
External rotation	45 degrees	50 degrees
Internal rotation	30 degrees	35 degrees
Flexion	125 degrees	120 degrees
Extension	Normal	Normal

CASE 8 (H26–116). R. F., female, aged twelve years and eight months, was first seen in May 1937 because of intermittent pain in the left hip, which had begun one year previously following a fall. Examination showed a large overweight girl who walked with a slight limp on the left. The length of the lower extremities was equal. Slight restriction of abduction of the left hip and slight fixed external rotation were present. The roentgenograms showed slight downward and backward displacement of the left upper femoral epiphysis and irregularity along the epiphyseal cartilage.

The patient was admitted to the hospital on June 7, 1937, and an operation was performed on June 9. Under general anaesthesia and without any attempt at reposition of the head, a lateral incision was made over the greater trochanter and a Smith-Petersen nail was inserted under roentgenographic guidance. Following operation, the patient was kept in bed for four weeks with light extension on the leg, and was then allowed up with a raised sole and crutches. She was discharged on July 17, 1937. Full weight-bearing was permitted at the end of two months.

When last examined on December 22, 1937, she presented no complaints and walked very well. There was one-half an inch of shortening of the left leg with slight limitation of internal rotation. The roentgenogram showed good position and the epiphysis fused. Comparative measurements were as follows:

	Left	*Right*
Length	30 inches	30½ inches
Abduction	35 degrees	38 degrees
External rotation	50 degrees	50 degrees
Internal rotation	10 degrees	20 degrees
Flexion	140 degrees	150 degrees

CASE 9 (H26-882). C. S., male, aged fifteen years and six months, was admitted to the hospital on September 9, 1937, with a history of intermittent but progressive stiffness and pain in the right hip of one year's duration. There was no definite relation to trauma. Examination showed an obese boy, of the hypopituitary type, with slight bilateral knock-knee and a marked left-sided limp. The motions of the left hip were limited in abduction, adduction, and internal rotation. External rotation was normal, and hyperextension was increased. The roentgenographic examination at this time showed rarefaction in the line of the epiphyseal cartilage and slight downward and backward displacement of the femoral head.

An operation was performed on September 17, 1937, and a Smith-Petersen nail was inserted by the usual technique without any attempt to replace the head. The patient was discharged two weeks later on crutches, and weight-bearing was prohibited for three months.

When last examined on December 28, 1937, three and one-half months after nailing, the hip was painless, and there was scarcely any limp. The right extremity showed shortening of one-fourth of an inch, and there was scarcely any appreciable limitation of motion. The roentgenographic examination showed the nail still in place and the epiphysis in good position and beginning to fuse. Comparative measurements were as follows:

	Left	*Right*
Length	35¼ inches	35½ inches
Abduction	20 degrees	35 degrees
Adduction	15 degrees	15 degrees
External rotation	45 degrees	40 degrees
Internal rotation	0 degrees	5 degrees
Flexion	120 degrees	125 degrees

SUMMARY

The diagnosis of slipping of the upper femoral epiphysis at an early stage, when the displacement is still minimal and not sufficient to cause any permanent functional impairment, permits an entirely different type of treatment from that which is necessary when serious deformity is present. Since early diagnosis depends chiefly upon the general practitioner, there is need of better instruction in the pathological and clinical appearances of this disease.

For epiphyseal slipping with minimal displacement the author advocates the insertion of a Smith-Petersen flanged nail under roentgenographic control, without arthrotomy of the hip. The advantages of this method are security and fixation, hastening of epiphyseal fusion, freedom from immobilization, and simplicity of after-care. This operation has been performed in nine cases with excellent results in all. Significant shortening of the extremity did not occur.

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LATERAL INTRODUCTION OF THE SCREW-BOLT IN INTRACAPSULAR FRACTURE OF THE HIP *

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In 1932, the author devised a rustless-steel screw-bolt for fixing the head onto the shaft in true intracapsular fracture of the hip, a principle of treatment previously shown to be sound in animal experimentation [1]. The original method [2] afforded excellent visualization of the fracture, permitted removal of interposed soft tissues, and enabled accurate introduction of the screw-bolt. Although close coaptation of the fragments was secured, the method required a major surgical operation which could be conscientiously advised in only a few selected cases. While internal fixation under direct exposure has many enthusiastic supporters, there has been a continuous search for a satisfactory means of introducing reliable fixation by a less extensive lateral surgical exposure. The sound mechanics of the screw-bolt principle for internal fixation of fractures of

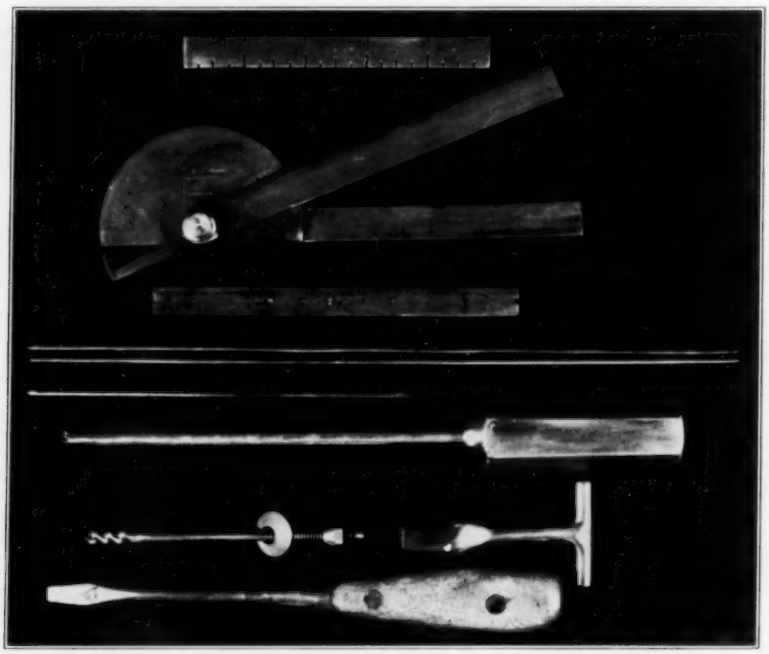

FIG. 1

Special instruments for lateral screw-bolting: (*a*) x-ray marker; (*b*) protractor; (*c*) steel rule; (*d*) Kirschner wires of equal length; (*e*) graduated Watson Jones pin; (*f*) hollow reamer; (*g*) improved screw-bolt and socket wrench; (*h*) screw driver.

* Presented before the British Columbia Medical Society, Vancouver, British Columbia, September 14, 1937.

FIG. 2-B
Fresh intracapsular fracture.

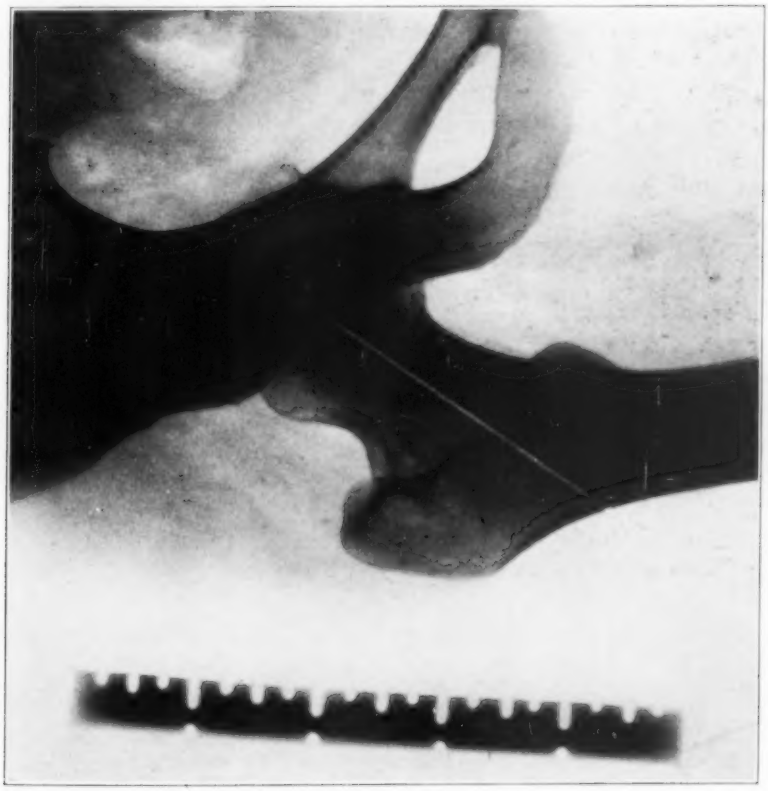

FIG. 2-A
X-ray of sound hip with Schanz marker.

FIG. 3-A

Fresh intracapsular fracture reduced in traction.

FIG. 3-B

Kirschner wire *in situ*.

the hip has appealed to others, and the author has developed a simple method of accurately introducing his rustless-steel screw-bolt through a small lateral incision. Only a few special instruments (Fig. 1) are required. If properly introduced, the screw-bolt does not tend to wander or to slip out, and bony union has been secured with it in spite of partial absorption of the neck. The improved method of lateral introduction is as follows:

The sound hip is x-rayed with a graduated marker (Fig. 2-A) and taped to the skin alongside the trochanter, as advocated by Schanz of Dresden. On such a roentgenogram of the sound hip, the angle of the femoral neck is measured precisely with a protractor. The exact length of the neck shadow, from the optimum point on the trochanteric side to the point of desired penetration into the head, is measured on the film with a steel rule. The exact length of screw-bolt penetration can then be computed * as the real length of the Schanz marker is known.

The fractured hip (Fig. 2-B) is reduced under general or local anaesthesia by the Leadbetter manipulation, and both extremities are put up in traction on the fracture table in moderate abduction (Fig. 3-A). Next a six-inch incision is made distal to the trochanter, and the upper femoral shaft is exposed subperiosteally. Two heavy Kirschner wires of exactly the same length are needed. One wire is introduced carefully with the hand drill at the angle set on the protractor as previously determined from the roentgenogram of the sound side. The exact amount of penetration is measured from time to time during insertion by removing the drill,

* Formula: Shadow of marker (measured on film) is to actual length of marker (known in inches) as shadow of neck (measured on film) is to real length of neck (x). The desired penetration is usually three and one-half to four inches.

FIG. 4-A

Hollow reamer following wire (Watson Jones guide pin not used in this case—note slipping of head).

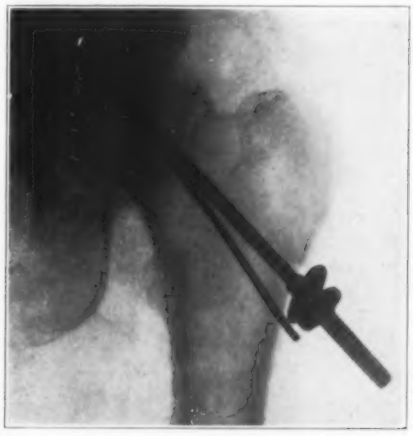

FIG. 4-B

Accessory pin to prevent rotation of head. Screw-bolt in place.

placing the second wire against the bony cortex alongside the first, and measuring the projecting remainder of the second wire over the inserted wire. By proceeding in this way there is no risk of penetrating the joint or the pelvis, and the guide wire can be introduced the exact predetermined distance (Fig. 3-B). Anteroposterior and lateral roentgenograms are made to verify the position of this guide wire; if it has not been precisely placed, the wire is withdrawn and introduced again, and the position verified with x-rays. A Moore pin or an engraved, graduated Watson Jones pin is inserted with a hand chuck alongside the guide wire, so as to engage the head and prevent rotation or displacement of the head temporarily (Figs. 4-A and 4-B). A graduated, hollow hand reamer, which follows the guide wire, but does not cut it, is used to bore a channel from the trochanteric side, so as to just enter the head. This is usually a distance three-quarters of an inch less than the penetration of the wire, and one must not cut too deeply into the head for fear of jeopardizing the firm bite of the whole screw tip in the bone of the head. The reamer and Kirschner-wire guide are withdrawn, and the rustless-steel screw-bolt is screwed into the unreamed head with a screw driver. The Watson Jones guide pin prevents rotation or displacement of the head during this

FIG. 5

End result. Screw-bolt and pin withdrawn.

manoeuver. The femoral head is then drawn tightly back onto the neck by tightening the machine-screw nut against a curved washer on the trochanteric end of the bolt. If the socket wrench is used, one must be careful not to strip the threads. Check-up roentgenograms are again made in two planes before the Watson Jones pin is withdrawn and the wound is closed.

No external fixation is necessary, and early motion of the extremity is encouraged to improve the local circulation. The protruding end of the bolt under the skin keeps the patient from lying on the affected hip during the healing period. Weight-bearing is not permitted for six months, or until roentgenograms reveal good bony union (Fig. 5).

After a thorough trial of weight-bearing, the entire screw-bolt and washer can be removed, if desired, through a small lateral incision under novocain; the screw-bolt is simply unscrewed with a screw driver.

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CORRECTION OF SCOLIOSIS BY A DISTRACTOR APPARATUS

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The principle of distraction for the correction of scoliosis is not new. The most commonly used method is that with the turnbuckle apparatus. We wish to present our method and to show some of the results. Although it has been tried in only six cases, it has produced a fair correction in each.

Three of the cases were due to infantile paralysis; one was caused by a pyogenic hip; and the remaining two were of unexplained etiology. The six patients ranged from thirteen to seventeen years of age. Three were boys and three were girls. Other forms of treatment had been tried previously without much success. Rotation of vertebrae was observed in the roentgenograms of five of the patients, who also had an accompanying kyphosis.

Our method is to apply a snug, well-molded body cast, with the patient lying on a Hawley table. We use an adjustable stand beneath the prominence, so as to obtain slight hyperextension. No felt is used and only a small amount of sheet wadding is applied over the bony prominences. Assistants maintain slight traction to the head and legs during the application of the plaster. It is important that the bandages are rubbed well, so as to produce a hard, light cast. It should extend high on the chest and low over the pelvis. The distractors are added to each side by simply wrapping a few rolls of plaster around them.

The threaded-tube type of distractor (Fig. 1) which we devised is

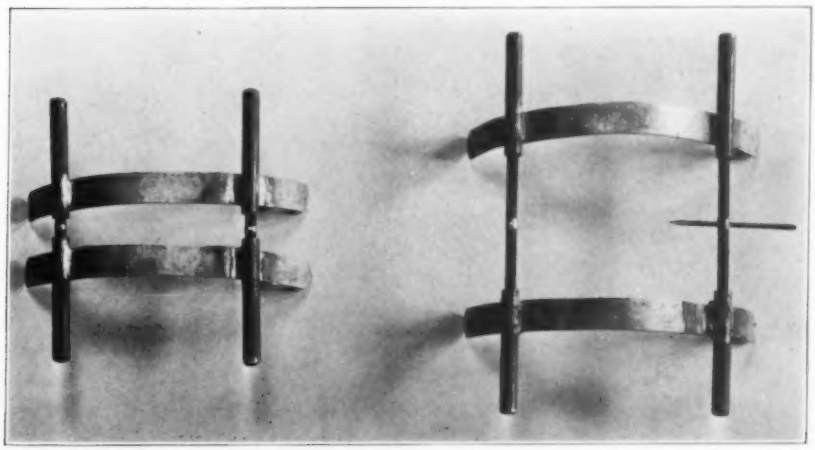

FIG. 1

Threaded-tube type of distractor.

FIG. 2-C

Case 1. M. C., June 6, 1937. Patient supine. There has been an increase in height of ten inches.

FIG. 2-B

Case 1. M. C., January 8, 1937, six months after distractor treatment. Patient supine in body cast with distractors. The pelvis is considerably lower than in Fig. 2-A.

FIG. 2-A

Case 1. M. C., March 6, 1936, before treatment. Patient supine. Note height of pelvis.

FIG. 3-A

Case 2. P. S., December 10, 1935. Clinic roentgenogram. Patient in erect position.

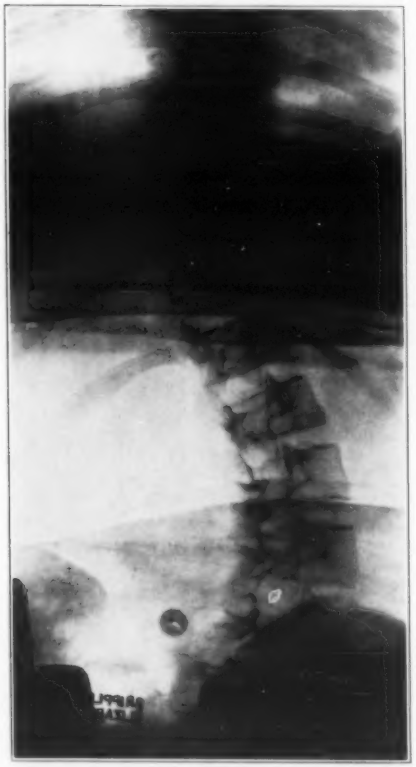

FIG. 3-B

Case 2. P. S., April 29, 1936, one month after distraction was begun. Patient supine in body cast with distractors.

FIG. 3-C

Case 2. P. S., June 3, 1936, on discharge. Patient supine.

FIG. 4-A

Case 3. W. E., January 28, 1937, on admission. Patient erect. The details are obscure because of the marked deformity. Note the height of the pelvis.

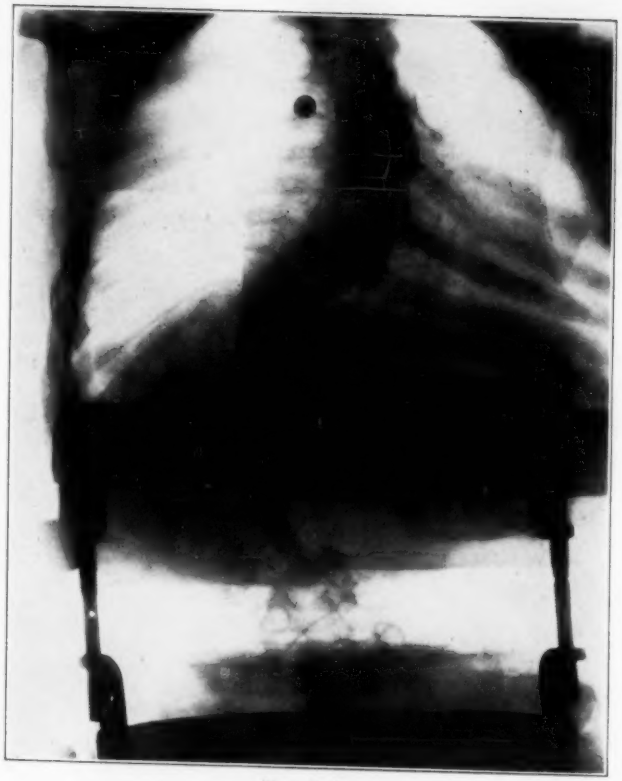

FIG. 4-B

Case 3. W. E., July 2, 1937, three and one-half weeks after treatment. Patient erect. Note that the pelvis is considerably lower than in Fig. 4-A. The patient was ambulant during treatment and there was an increase in height of five inches in four and one-half weeks.

superior to loose turnbuckles or the exposed-thread type, which we formerly used. They can be entirely incorporated in the plaster, making application easy; they are comfortable; and they are not visible under clothing. Four days are required for drying. Then the cast is split horizontally (opposite the apex of the curvature if possible), producing lower and upper portions. Distraction must be slow and gradual. A quarter of a turn daily is sufficient. If the patient complains of "burning", it is best to postpone the distraction for a few days. In one of our cases, in which distraction was rapid, a pressure sore developed. Usually a few days are required before the ascending portion of the cast grasps the upper thorax and the descending portion grasps the pelvis. The circumference of the upper thorax and of the pelvis is greater than of the intervening region, causing the spine to be stretched between them. Each distractor is turned an equal distance. No attempt is made to increase the correction on one side.

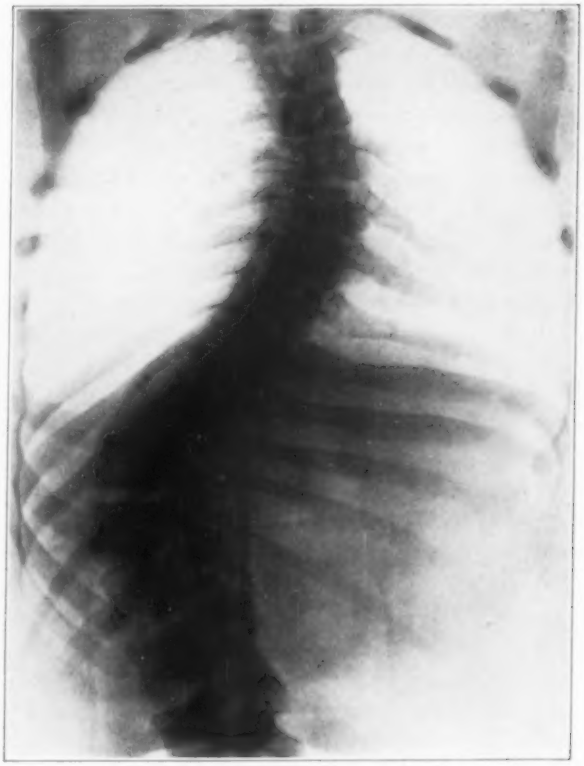

FIG. 4-C

Case 3. W. E., December 6, 1937. Final roentgenogram showing tibial graft. Patient supine. There has been an increase in height of eight inches.

FIG. 4-D

Case 3. W. E., in cast with distractors.

After satisfactory correction has been obtained, a brace may be applied. Sometimes the spread is maintained by wooden wedges and a fusion operation is performed through a window in the back of the cast. In Case 1, we applied three distractor casts, decreasing the curvature each time. However, each case is an individual problem and it is beyond the scope of this paper to discuss the procedure, once satisfactory correction has been obtained.

The patient in Case 1, whose condition was due to destructive hip-joint disease, was made ten inches taller by the apparatus. She was in the hospital for over a year. During this time she also had several operations on the involved leg. This permitted us to proceed gradually. The patients in Cases 2 and 3, in whom the scoliosis was the result of infantile paralysis, were made three and one-half and five inches taller, respectively, after one month's treatment. In Case 3 the patient was ambulant during treatment. The correction in these cases is easily recognized in the roentgenograms. The marked lowering of the pelvis and the decrease in angulation are well demonstrated.

We do not believe that a distractor apparatus should be used in every case of scoliosis. The principle of correction must be borne in mind. Although we obtained good results in all our cases, we were careful to choose the types of patients suited for this procedure. It should not be attempted on an obese individual or on one with poor chest development. It is a good plan to measure the abdomen and upper chest and if the latter is not a few inches greater the procedure should not be attempted.

We have not found it necessary to incorporate the chin and pelvis in the cast as is done by Moore. In all our cases, simple body casts were sufficient. We do not keep all our patients in bed. The fact that in Case 3 an increase in height of five inches was obtained after one month of treatment has encouraged us to try this method in the future whenever feasible. We believe in some instances that it is a good plan to combine or to alternate simple distraction with the methods of Hibbs, Risser, and Ferguson, Galeazzi, and others.

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TREATMENT OF LOCALIZED FIBROCYSTIC CAVITIES IN BONE BY CURETTAGE AND PACKING WITH BONE CHIPS *

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One of the interesting moments in an orthopaedic surgeon's practice occurs when he examines the roentgenogram of a patient and sees a cavity in the shaft or near the end of one of the bones. Of the lesions which can cause such a cavity, those under discussion in this paper comprise a group which are relatively benign, and yet, if left to their own devices, show a tendency to progressive expansion and absorption of the bone with the production of pain, deformity, and disability. According to present-day pathological conceptions, they seem to belong to the same family which may be called by the surname of localized fibrocystic disease of bone, and they seem to exhibit many similarities of clinical appearance and behavior. On the other hand, they do show marked differences of the actual local pathology, on the basis of which they have been divided into the following three groups for purposes of this study: (1) lesions which are found to be cavities in the shaft of the bone, filled with fluid and surrounded by a limiting fibrous membrane, called bone cysts; (2) lesions which are cavities in the shaft of the bone, filled with firm, cellular, fibrous tissue, described as osteitis fibrosa cystica; and (3) lesions which are cavities at the epiphysis, filled with soft, vascular tissue of characteristic microscopic appearance, diagnosed as giant-cell tumors.

As this paper is concerned with treatment, we shall pass over the interesting questions which arise in a discussion of the etiology and nature of these lesions, and confine ourselves to the way in which they have been treated at the New York Orthopaedic Dispensary and Hospital, and with what results.

The problem of treatment is twofold: how to stop the activity of the disease, for we know it may progress if left alone; and how to set the stage so that orderly repair processes may restore the bone to a healthy state. Although some men have handled this problem by the use of roentgenotherapy and others by surgical curettage and cauterization, reporting more or less satisfactory results, the surgeons at the New York Orthopaedic Hospital have dealt with it surgically by curettage of the cavity, followed by packing it with bone chips without cauterization. The advantages of this approach are several. In the first place, a more exact diagnosis is possible if the lesion is actually seen and tissue from it is studied microscopically. Second, if the diseased tissue is removed as com-

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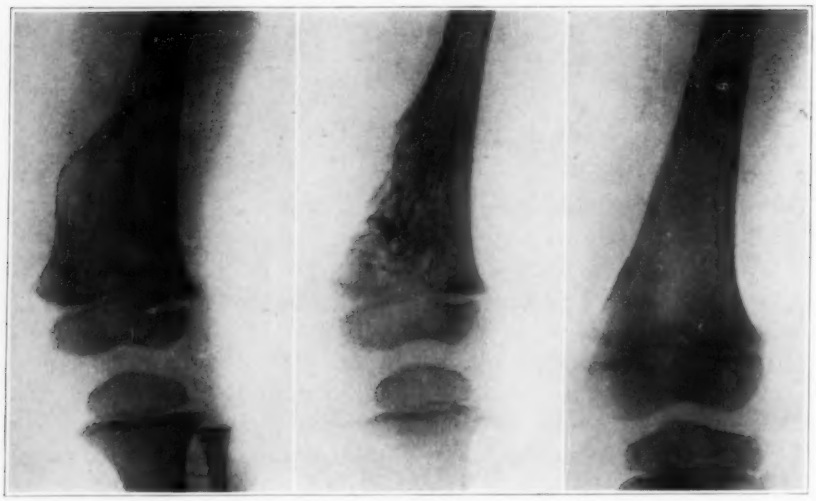

FIG. 1-A FIG. 1-B FIG. 1-C

Bone cyst filled with fluid in the lower end of the femur of a male, three years old. There were no symptoms. Swelling of the knee was noted by the child's mother.
Fig. 1-A: Cavity before curettage and packing with bone chips.
Fig. 1-B: Two months after operation.
Fig. 1-C: Two and one-half years after operation. Lesion healed.

pletely as possible, it would seem that the processes of repair would have the best environment in which to function. Third, if the cavity is filled with small bone chips, a framework for the new, vascular, fibroblastic repair tissue is provided, as well as a concentrated source of calcium and phosphorus salts which will be available at the place where they are needed as soon as local conditions are right for the formation of new bone.

Our conception of the process of repair that occurs in a cavity which has been filled with bone chips may be stated briefly. Blood or serum fills the spaces around the individual chips. As clotting takes place, the fibrin network binds the bone chips together, and the whole area then becomes infiltrated by a rapidly growing, vascular, fibroblastic tissue. The bone chips themselves quickly lose their individual cells and, if examined under the microscope after a few days, will appear like dead bone. However, in spite of this, and as early as the second week, a layer of new bone is formed around and intimately adherent to the outer surface of each chip, while trabeculae of new bone appear in the narrow spaces between the chips. These trabeculae will join the new bone formed around the chips, so that a network of trabeculated bone is developed with the apparently dead chips as integral parts. The old chips may remain and be recognizable for a long time, but they do not seem to act as irritating foreign bodies or sequestra, nor do they appear to encourage the development of giant cells around their margins. Eventually they lose their identity through some process of resorption as the structure of the bone approaches nearer to a healthy state. It is felt that the bone chips add a

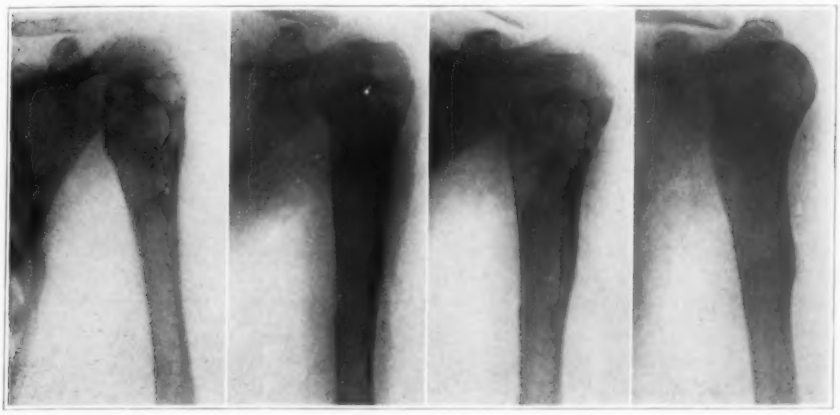

FIG. 2-A FIG. 2-B FIG. 2-C FIG. 2-D

Bone cyst filled with fluid in the upper end of the humerus of a female, eight years old. There were no symptoms until a fracture through the lesion occurred. The fracture united, but the lesion progressed.

Fig. 2-A: Cavity in humerus before curettage and packing with chips.

Fig. 2-B: Five months after operation. The lesion was thought to be healing, but at the end of sixteen months a recurrence was noted.

Fig. 2-C: Three years after operation. The lesion had become larger and at operation it was found to be filled with fluid. The cavity was curetted and packed with chips.

Fig. 2-D: Two years after the second operation. Lesion healed.

definite stimulus to the osteogenic-repair process and that their presence materially hastens the healing of the cavity.

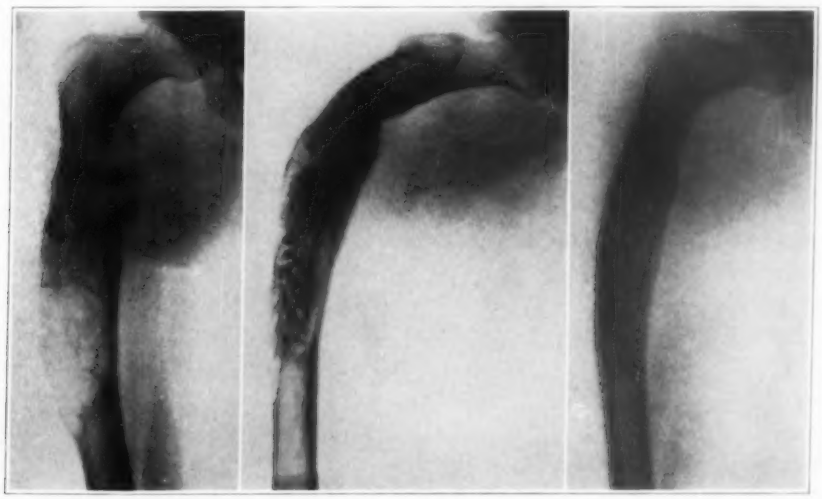

FIG. 3-A FIG. 3-B FIG. 3-C

Osteitis fibrosa in the shaft of the femur of a female, eighteen years old. The symptoms were of seven years' duration. There had been a steady increase in the size of the lesion in spite of three courses of roentgenotherapy.

Fig. 3-A: Cavity in femur before curettage and packing with chips.

Fig. 3-B: Five months after operation.

Fig. 3-C: Eight years after operation. Lesion healed.

TABLE I

ANALYSIS AND RESULTS OF SIX CASES OF BONE CYSTS

Number of patients	6
Average age of patients	9 years
Number of recurrent lesions	2 (33 per cent.)
Number of operations for recurrence:	2 (2 patients)
Curettage and bone chips 2	
Average time when recurrence was noted	15 months
Average follow-up period	3 years
Number of lesions healed	6 (100 per cent.)
Number of lesions not healed	0
Number of deaths	0

That this type of repair is a complicated one, involving many chemical and pathological factors which are not understood, goes without saying, and, therefore, it is to be expected that some lesions may not follow the rule. There are recurrences after curettage and packing with bone chips, and here again it is hard to understand or to explain the factors involved. It is interesting that the actual pathology found in a recurrent lesion is usually similar to that which was seen in the original cavity,—that is, the contents will be made up of either fluid, or fibrous tissue, or giant-cell tumor. It is also interesting that recurrent lesions treated by curettage and packing with bone chips will usually heal satisfactorily, although several operations may be necessary.

The surgeons at the New York Orthopaedic Hospital began in 1922 to treat fibrocystic cavities in bones by thorough curettage and packing with small bone chips usually obtained from the shaft of the tibia. Between 1922 and 1935, twenty-eight patients who presented such lesions were treated in the manner outlined and the cases were classified according to the three groups which have already been mentioned,—bone cysts, osteitis fibrosa, and giant-cell tumors.

Bone Cysts

These were six in number and occurred in the youngest age group, the average age being nine years. Four were in males and two in females. The humerus was involved three times and the radius, femur, and fibula each once. Four of the six lesions were recognized after a fracture at their site; one was discovered because of pain; and one was found incidental to an examination for a foot complaint. Eight operations were performed on these six patients, as two lesions recurred, each recurrent lesion being a cyst filled with fluid and without any evidence of bone chips. The results in this group are shown in Table I. Each patient has been well, with roentgenographic evidence of healthy bone repair, for at least one year after operation. The average follow-up period is three years.

Osteitis Fibrosa

There were fifteen patients in this group,—eleven females and four males of an average age of twelve years. The femur was involved six times, the tibia and the humerus each three times, and a metatarsal bone, a fibula, and a finger phalanx each once. These fifteen patients required twenty-three operations, as six of them had lesions which recurred after the first operation. One of these lesions, in a tibia, showed great persistence, as it returned three times in the original location and once higher up, so that this individual required five operations before a cure was effected. Another patient had a lesion which recurred after a second operation. One patient had a large cavity in the trochanter and neck of the femur, which had been treated without effect by roentgenotherapy for one and one-half years. This patient was operated upon and seemed to be doing well for ten months, after which time the lesion recurred. This patient and the preceding one have been lost to the Follow-Up Clinic. Another patient has in the humerus a recurrent lesion of much smaller size than the original cavity, and during six years it has shown no tendency to increase, so that its character has probably been altered. A lesion in the upper end of the humerus recurred twice, but has been cured by the third operation. There was one recurrence in the phalanx of a finger, but the lesion has remained healed after the second curettage and packing with bone chips. The final results in this group are shown in Table II. One patient, a child of seven, died of shock soon after the operation which was performed on a hot summer day. The lesion was a large one in the shaft of the

FIG. 4-A FIG. 4-B FIG. 4-C

Osteitis fibrosa in the upper part of the shaft of the femur in a male, six years old. Pain and a limp had been present for two months.
Fig. 4-A: Cavity in the shaft of the femur before curettage and packing with chips.
Fig. 4-B: One month after operation.
Fig. 4-C: Seven years after operation. Lesion healed.

femur and had been present for at least two years, during which time there had been two fractures through the area without any tendency for the disease to become arrested, although the fractures had united. Eleven of the patients are considered to be entirely healed after a follow-up period averaging four years, and three patients have recurrent lesions.

FIG. 5-A

Giant-Cell Tumors

Seven patients were included in this group, with an average age at the time of operation of eighteen years. There were five females and two males. The lower end of the tibia was involved in two cases, and in the other five cases the lesions were located in the upper end of the femur, in the upper end of the humerus, in the os calcis, in the lower end of the ulna, and in the pedicle of the third lumbar vertebra. In all, twelve operations were performed on these seven patients. One patient with a lesion in the lower end of the ulna had four operations before a cure was obtained, because the lesion recurred twice in the same site and once in the adjacent por-

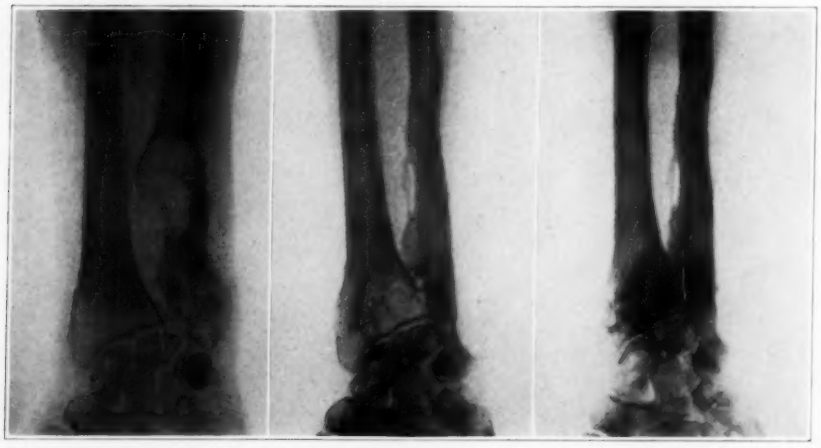

FIG. 5-B FIG. 5-C FIG. 5-D

Giant-cell tumor in the lower end of the ulna of a female, forty-two years old. There had been a steady increase in the size and symptoms for four years in spite of treatment by roentgenotherapy.

Fig. 5-A: Lesion at time of curettage and packing with bone chips.

Fig. 5-B: One year after operation. Recurrent lesion in upper part of original cavity. A second operation, consisting of resection and a bone graft, was performed.

Fig. 5-C: Two years after second operation. Lesion in ulna healed. New area of giant-cell tumor in lower end of radius. This was curetted and packed with bone chips. Recurrence after one year. Lesion again curetted and packed.

Fig. 5-D: One and one-half years after fourth operation. Lesions in ulna and radius are healed.

TABLE II

ANALYSIS AND RESULTS OF FIFTEEN CASES OF OSTEITIS FIBROSA CYSTICA

Number of patients	15
Average age of patients	12 years
Number of recurrent lesions	6 (40 per cent.)
Number of operations for recurrence:	8 (4 patients)
Curettage and bone chips 8	
Number of recurrent lesions not operated upon	2
Average time when recurrence was noted	12 months
Average follow-up period	4 years
Number of lesions healed	11 (73 per cent.)
Number of lesions not healed	3 (20 per cent.)
Number of deaths (operative)	1 (7 per cent.)

tion of the radius. Before surgery was used, the patient had had a long course of roentgenotherapy, sufficient to cause considerable necrosis of the lesion but not to effect healing. In two cases, a leg was amputated. In one of these, the lesion was in the os calcis, and for ten months after the curettage the condition seemed to be healing. Then a recurrence was noticed and, in spite of treatment by roentgenotherapy over a period of five months, the lesion continued to increase in size. A second curettage was advised, but declined, and the patient continued with roentgenotherapy until the skin broke down. Four years later the leg was amputated because of persisting sinuses and continuance of the lesion. In the other case, the lesion was in the lower end of the tibia, and the leg was amputated one month after the original curettage because the lesion was suspected of being malignant. Table III shows the results in this group of giant-cell tumors and demonstrates that all the patients have remained well for an average follow-up period of five years.

TABLE III

ANALYSIS AND RESULTS OF SEVEN CASES OF GIANT-CELL TUMOR

Number of patients	7
Average age of patients	18 years
Number of recurrent lesions	3 (43 per cent.)
Number of operations for recurrence:	5
Curettage and bone chips ..... 3 (1 patient)	
Amputation 2	
Average time when recurrence was noted	10 months
Average follow-up period	5 years
Number of lesions healed	5 (71 per cent.)
Number of lesions not healed (amputation)	2 (29 per cent.)
Number of deaths	0

TABLE IV

SUMMARY OF TWENTY-EIGHT CASES OF FIBROCYSTIC LESIONS TREATED FROM 1922 TO 1935 *

Diagnosis	Average Age of Patients (*Years*)	No. of Patients	Lesions Which Recurred		Total No. of Operations
			No.	*Per Cent.*	
Bone cyst	9	6	2	33.0	8
Osteitis fibrosa	12	15	6	40.0	23
Giant-cell tumor	18	7	3	43.0	12
Total		28	11	39.0	43

Diagnosis	Results							
	Lesion Healed		Lesion Unhealed		Amputation		Death	
	Cases	*Per Cent.*	*Cases*	*Per Cent.*	*Cases*	*Per Cent.*	*Cases*	*Per Cent.*
Bone cyst	6	100.0	0	0.0	0	0.0	0	0.0
Osteitis fibrosa	11	73.0	3	20.0	0	0.0	1	7.0
Giant-cell tumor	5	71.0	0	0.0	2	29.0	0	0.0
Total	22	79.0	3	11.0	2	7.0	1	3.0

* 28 patients had 43 operations: 1 patient died of shock; each of 2 patients had a leg amputated; 3 patients have unhealed lesions; 22 patients have healed lesions.

SUMMARY

The results obtained in the twenty-eight patients of the series are shown in Table IV and reveal several interesting comparisons between the three groups. These lesions have a marked tendency to recur locally, as demonstrated by a 39-per-cent. recurrence in this series. It is important to realize that the average time when the recurrences were noted was as late as one year, so that a long follow-up period is necessary. The local recurrences can be treated successfully in the same way as the original lesions, even though some cases may require several procedures before a cure is obtained. The three patients who still have unhealed lesions are all in the osteitis-fibrosa group, and two of them have been lost to the Follow-Up Clinic without having had the second operation which was advised. In the other case there is an unhealed area which has not increased at all over a period of six years. It is so small that further treatment has not been advised.

Although 79 per cent. of the lesions have healed satisfactorily, the variations in the percentage of success among the three groups must be noted. Because of the similarities which have been observed in the behavior of these lesions under treatment, it is believed that curettage and packing with bone chips is an effective method of dealing with them, and that, as larger numbers are accumulated, the percentage result in each group will tend to be more satisfactory.

SUBCUTANEOUS TENOTOMY OF THE ACHILLES TENDON

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Tenotomy of the Achilles tendon is one of the simplest and most universal procedures in orthopaedic surgery. The surgeon, confronted with the problem of a short heel cord, usually chooses to obtain length by a plastic operation on the tendon or by a subcutaneous tenotomy. The decision depends largely upon the age of the patient, the etiology, and the degree of deformity. Lengthening of the tendon is not sufficient in itself in many instances and must be performed in conjunction with other operative procedures on the foot. The question of the relative value of the open plastic operation and the subcutaneous tenotomy arises.

Both methods are universally described and accepted as good treatment. A number of authors make definite statements as to when and when not to employ subcutaneous tenotomy; others make no comment.

Jones and Lovett warned against subcutaneous tenotomy in spastics and in cases of poliomyelitis. They stated definitely that they preferred the open plastic method. They did, however, utilize the subcutaneous section for the correction of club-foot in infants.

Soutter stated that in large clinics, where thousands of tenotomies had been done, lack of union was almost never seen. He, nevertheless, seemed to favor zig-zag lengthening in preference to transverse section. These are opposing ideas.

Whitman tells us that the open plastic operation is theoretically a safer procedure. He states, further, that subcutaneous tenotomy is preferable when the tendon lengthening is an incident in the treatment of club-foot. These are also opposing statements.

Calot determines his method by the required amount of lengthening. For children, when the necessary correction does not exceed one centimeter, and for adults, when the correction does not exceed two and one-half centimeters, he uses the subcutaneous tenotomy. When the correction required is greater than these figures, he recommends the open plastic method.

Mercer utilizes the closed method for club-foot. He employs both methods for spastics. For the deformity following poliomyelitis, however, he employs only the open plastic method.

Moore described only the technique of subcutaneous tenotomy in lengthening the heel cord in club-foot and in poliomyelitis.

Brockman employs only the subcutaneous tenotomy in club-foot.

Galland, in 1924, discussed the poor results from subcutaneous section. He described a closed plastic lengthening which he much preferred to the simple tenotomy.

FIG. 1

After subcutaneous tenotomy. Note the atrophied gastrocnemius, the threadlike heel cord, and pes cavus.

It would seem from these authors that plastic lengthening is the preferable method of procedure, but, despite the definite statements of some, the surgeon is left to make his own decision, largely from his own experience. There is no doubt that in the vast majority of subcutaneous tenotomies performed on the heel cord firm union results. However, not infrequently come to our attention patients whose functional results are not of the best. These unfortunate patients present an atrophied gastrocnemius, a threadlike heel cord, and a pes cavus. (See Figure 1.)

The development of this deformity is fairly clear. Behind the external malleolus the peronei run posterior to the transverse axis both of the ankle and of the midtarsal joints. They, therefore, act as flexors. The posterior tibial tendon runs in like manner behind the medial malleolus, and also acts as a flexor to the ankle and midtarsal joints. (See Figure 2.)

Normally, these muscles act synchronously with the gastrocnemius, the soleus, and the plantaris. The Achilles tendon, partially or wholly ununited, either does not act in its normal capacity or fails to function. The body of the os calcis, then, is not acted upon directly in plantar flexion. In an attempt at plantar flexion, midtarsal flexion occurs first by the action of the peronei and tibialis posterior plus the long toe flexors (Fig. 2). When the forefoot is thus flexed, there follows slight excursion of the os calcis (Fig. 3). This action decreases the distance between the origin and insertion of the short toe flexors and plantar fascia, gradually deepening the longitudinal arch (Fig. 4).

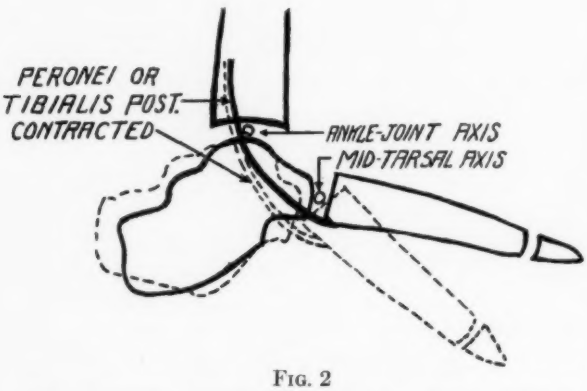

FIG. 2

Diagrammatic drawing, illustrating the development of the deformity shown in Fig. 1.

This Clinic has used both methods of lengthening the Achilles tendon. Our attention was sharply called to seven cases operated upon within a four-year period. Because these cases demonstrated the deformity just described, a serious doubt arose as to the virtue of the closed operation.

Five children were operated upon for club-foot; in one case the deformity was bilateral. The ages of the patients were four weeks, three months, seven months, nine months, and twenty-four months. Two children —one a case of spastic hemiplegia, and the other a case of residual poliomyelitis— were operated upon at seventeen months.

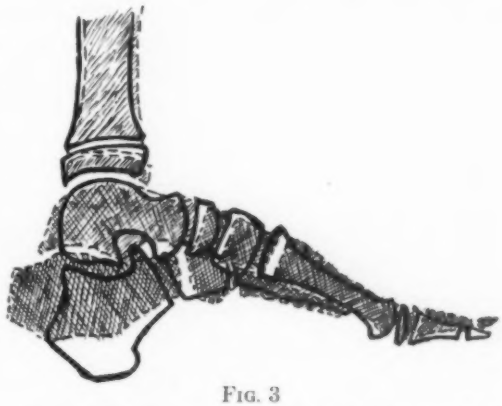

FIG. 3

Drawing showing slight excursion of the os calcis when the forefoot is flexed.

A study of the cases revealed no unusual facts. All underwent the subcutaneous tenotomy. Each patient was placed in a plaster-of-Paris cast from the toes to the groin. The knee was held in 90 degrees of flexion and the foot in from 90 to 100 degrees of dorsiflexion for a period of from six to eight weeks. This method of treatment in general corresponded to that used in other clinics.

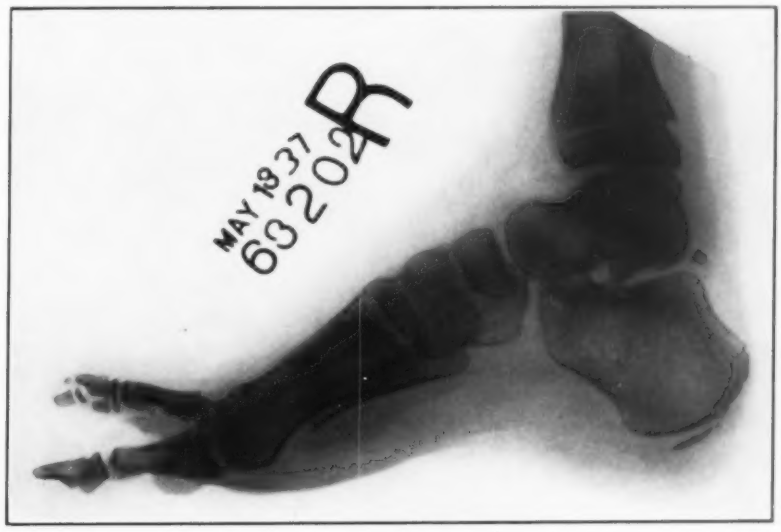

FIG. 4

Roentgenogram showing the deepening of the longitudinal arch as the result of the conditions illustrated in Figs. 2 and 3.

A review of the texts and literature did not add much to our knowledge, nor did it give us more definite criteria to guide us in choosing the type of operation. We, therefore, sent out a number of questionnaires to general surgeons and orthopaedic surgeons, asking for their views on this subject. The enthusiasm, the promptness of the replies, and the definite

TABLE I

Summary of Opinions in Regard to Subcutaneous Tenotomy of the Achilles Tendon

Name	For	Against	Questionable *	Remarks
LeRoy C. Abbott San Francisco, California		X		Tenotomy has not been done for many years.
Carl E. Badgley Ann Arbor, Michigan		X		Tenotomy has not been done for many years.
George E. Bennett Baltimore, Maryland	X			Utilized only in very small children.
Willis C. Campbell Memphis, Tennessee			X	Utilized in club-foot in infants.
Fremont A. Chandler Chicago, Illinois		X		Never employ tenotomy.
Edward L. Compere Chicago, Illinois			X	Open operation preferred.
Frank E. Curtis Detroit, Michigan		X		Never used this procedure.
Vernon L. Hart Minneapolis, Minnesota		X		Should not be done if function is expected.
Melvin S. Henderson Rochester, Minnesota		X		Open operation preferred.
Michael Hoke Atlanta, Georgia.			X	Only employed in infants.
R. Watson Jones Liverpool, England			X	Tenotomy rarely indicated.
Frederick C. Kidner Detroit, Michigan		X		Tenotomy has not been done for twenty years.
Don King San Francisco, California		X		Tenotomy never done.
Samuel Kleinberg New York, N. Y.	X			Achillotomy, only a small part of procedure.
A. D. LaFerté Detroit, Michigan			X	Employed only in club-foot in infants.
Arthur T. Legg Boston, Massachusetts		X		Tenotomy is never done.
Paul B. Magnuson Chicago, Illinois	X			Has never had a case in which healing failed to take place.
Beveridge H. Moore Chicago, Illinois		X		Not been utilized for years.
Frank R. Ober Boston, Massachusetts		X		Not been used for years.
Charles W. Peabody Detroit, Michigan		X		Procedure is physiologically unsound.
Dallas B. Phemister Chicago, Illinois	X			Has not seen atrophy in small children.
Edwin W. Ryerson Chicago, Illinois			X	Tenotomy only utilized as last resort.
Arthur Steindler Iowa City, Iowa		X		Tenotomy has practically been given up.
Philip D. Wilson New York, N. Y.		X		Never sever tendon. Staggered hemisection.
Paul C. Williams Dallas, Texas		X		Never employed tenotomy.

* This classification is purely arbitrary and is the authors' reaction to statements made in the letters received.

opinions expressed denoted unusual interest. Table I is a summary of the current feeling in regard to subcutaneous tenotomy.

COMMENT

This Clinic has abandoned subcutaneous tenotomy of the Achilles tendon because of poor function obtained in seven cases. Stretching of the Achilles tendon with the application of a plaster-of-Paris cast and bone surgery on the feet are more satisfactory in the end.

Our own interpretation of the communications which we have received is that the majority of surgeons hold subcutaneous tenotomy of the Achilles tendon as an unfavorable surgical procedure which must give way to more physiologically sound methods.

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NON-UNION OF FRACTURES OF THE CARPAL NAVICULAR

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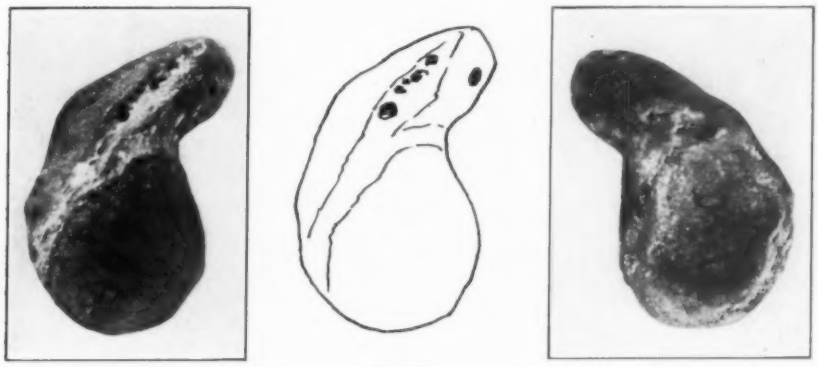
The tendency of fractures of the carpal navicular to result in non-union has come to be recognized as a distinct characteristic of this fracture which is one of the most serious and disabling traumatic affections of the wrist. Most authorities cite inadequate fixation of the wrist as the chief cause of non-union. They also prefer plaster of-Paris splints or casts as the means of fixation. There is no such unanimity of opinion concerning the position of the wrist during the period of immobilization. However, since equally good results have been reported by surgeons who favor different positions,[2, 3, 9, 10] it is reasonable to assume that the position of the wrist during immobilization is not of primary importance. The period of fixation also varies, being given at from six weeks to six months by various authors.[4, 7, 8, 12] Studies of the healing processes in experimentally produced fractures of the carpal navicular in dogs [5] have shown that bones of the cancellous type heal more slowly than the long bones. This is due largely to lack of subperiosteal callus formation, but it is also due in part to the fact that the cancellous reaction is less extensive and active than the medullary response in the diaphysis. Experience shows, however, that other bones of this cancellous type, such as the bones of the tarsus, heal without delay after fracture or osteotomy. It has also been found experimentally [5] that there is no lytic action of the synovial fluid and, therefore, this cannot be considered responsible for non-union. Studies of the blood supply of the carpal navicular by injection of the arteries with opaque media [6, 8] have shown variations in the positions of the vessels, giving rise to the belief that these variations are important factors in the union of fractured naviculars.

The authors carefully examined 297 carpal naviculars which had been removed from cadavera in the Department of Anatomy of the State University of Iowa. The navicular, freed of its soft-tissue attachments, is found to be almost entirely smooth. Most of its surface consists of articular cartilage, for it articulates with five bones,—the radius, the lunate, the greater multangular, the lesser multangular, and the capitate. There is a narrow rough ridge running obliquely around the dorsal surface from the tuberosity on the lateral side to the proximal base medially. In this ridge are found the arterial foramina, and it is through these apertures that the bone receives its blood supply.

In most of the bones examined it was found that the largest foramina were situated in the distal half of the bone, particularly near the tuberosity. In 13 per cent. of the bones there were no arterial foramina proximal

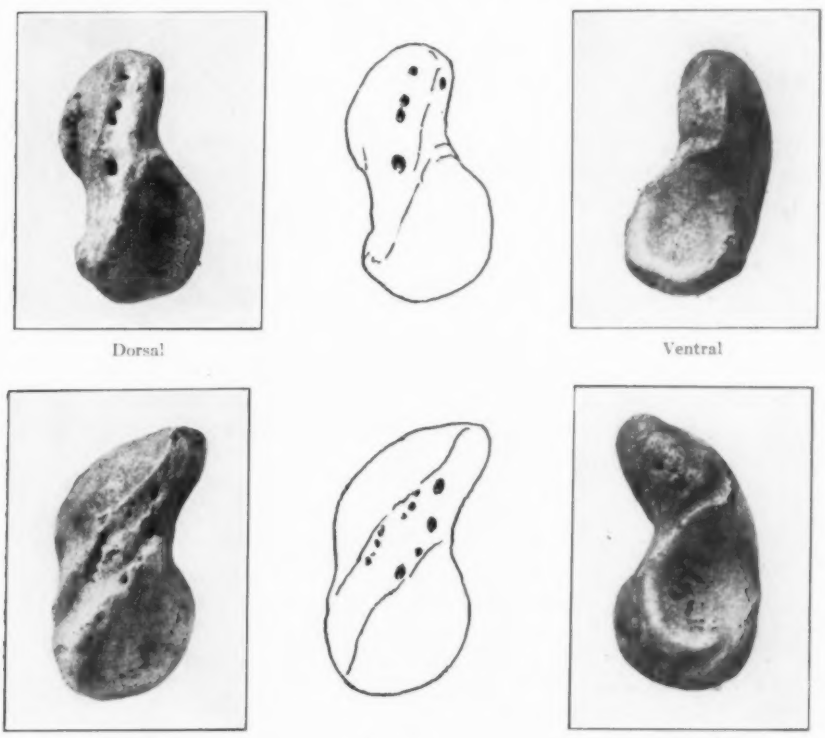
* Service of Arthur Steindler, M.D.



Dorsal FIG. 1 Ventral

Type of navicular showing no arterial foramina proximal to the mid-portion or "waist" of the bone, at which point fracture is most likely to occur. The proximal fragment is totally devoid of blood supply in case of fracture.

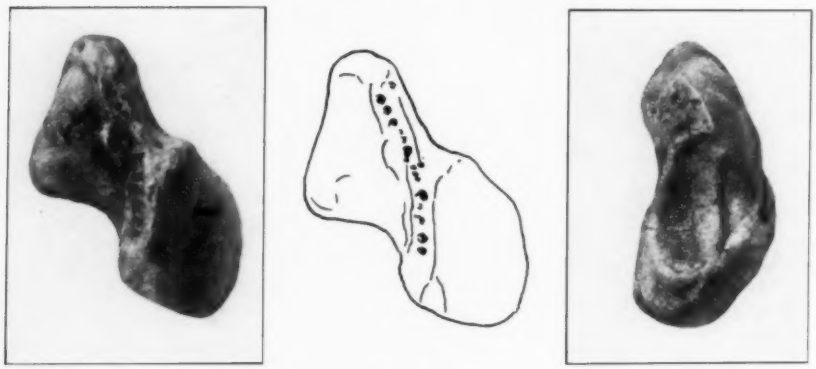
to the constricted mid-portion or "waist" of the bone. (See Figure 1.) In 20 per cent. of the bones examined there was a single small arterial foramen at the waist or proximal to it. (See Figure 2.) In 67 per cent.



Dorsal Ventral

Dorsal FIG. 2 Ventral

Types of navicular showing one arterial foramen at or proximal to the mid-portion. The nutrition of the proximal fragment is probably inadequate where fracture occurs through the mid-portion of the bone.



Dorsal FIG. 3 Ventral

Type of navicular showing two or more arterial foramina proximal to the "waist" of the bone. The nutrition of the proximal fragment is probably adequate if fracture occurs.

there were two or more foramina proximal to the waist. (See Figure 3.) These findings are significant, for most of the fractures of the navicular occur through the waist of the bone. Such fractures would completely interrupt the blood supply to the proximal portion of the bone in at least 13 per cent. of the cases, and would definitely interfere with proper nutrition of the proximal fragment in another 20 per cent. Therefore, in one-third of the instances in which the navicular is fractured through the mid-portion the blood supply is diminished to such an extent that necrosis may occur, and non-union can then be expected. However, if the immobilization is absolute and prolonged for a sufficient period, the necrotic portion will be revitalized by the formation of new blood channels, and union of the fragments can then occur.

Thirty cases of non-union of the carpal navicular were studied. All the patients were men in the most active period of life,—from eighteen to forty-eight years of age. They came to the Clinic on an average of fifteen months after the fractures had occurred. In seventeen cases the fractures had not been recognized, and the wrists had received no immobi-

TABLE I

CLINICAL EXAMINATION

Findings	No. of Cases	Per Cent.
Pain in wrist	30	100
Limited flexion and extension	21	70
Swelling	14	47
Weakness of grip	11	37
Tenderness in snuffbox	11	37
Diffuse tenderness	11	37
Arthritic changes	3	10
Associated carpal injuries	4	13

TABLE II

ROENTGENOGRAPHIC EXAMINATION

Findings		No. of Cases	Per Cent.
Simple fracture line through mid-portion		10	33
Comminution		2	7
Cyst formation		6	20
Necrosis:		3	10
Proximal fragment	2		
Both fragments	1		
Osteo-arthritis		3	10

lization treatment after the injury. In all of the other cases the immobilization was woefully inadequate, both as to the type of fixation used (slings, adhesive strapping, wood, metal, or plaster-of-Paris splints, etc.) and as to the duration of the period of fixation.

The clinical and roentgenographic findings at the time of the first examination in the Clinic are recorded in Tables I and II.

Only twenty-one of the thirty patients remained for treatment. In seven cases conservative treatment, consisting of immobilization in a cock-up splint or cast of plaster-of-Paris, was instituted. Operative treatment was used in fourteen cases. Excision of one or more fragments was the operation of choice prior to the introduction of the drilling operation by Beck in 1929. The excision completely alters the architecture of the wrist to such an extent that it is indicated now only as a final means of removing the source of pain in comminuted fractures. The drilling operation is much simpler and far less mutilating. Table III shows the end results obtained by the two types of treatment.

SUMMARY AND CONCLUSIONS

The necessity for prolonged immobilization of the wrist in fractures of the carpal navicular in order to prevent non-union is due to the anatomical variations in the blood supply to the bone. In 13 per cent. of 297 carpal naviculars studied grossly there were no arterial foramina proximal to the

TABLE III

END RESULTS

Treatment	Total Cases	Cases Improved	Cases Not Improved	Cases Not Followed Up
Conservative	7	1	2	4
Operative:	14	9	2	3
Partial excision	4	4	0	0
Complete excision	6	1	2	3
Drilling	4	4	0	0

mid-portion of the bone, the commonest site of fracture. In 20 per cent. there was one arterial foramen proximal to the waist, while in 67 per cent. two or more foramina were found. Fracture through the mid-portion of the bone could, therefore, interrupt the blood supply in about one-third of the cases and lead to necrosis. Unless immobilization is absolute and prolonged, non-union is liable to develop in these cases.

Conservative surgery (Beck's drilling), followed by adequate immobilization, is the treatment of choice for non-united fractures of the carpal navicular. It is less mutilating than either partial or complete excision of the navicular and results in bony union without alteration of the normal architecture of the wrist.

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TENSILE STRENGTH OF THE ANTERIOR LONGITUDINAL LIGAMENT IN RELATION TO TREATMENT OF 132 CRUSH FRACTURES OF THE SPINE *

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In a previous paper, submitted for membership in the American Orthopaedic Association in 1927 and published in abbreviated form in 1929, the author stated that the anterior longitudinal ligament could be depended upon to remain intact during the period of stress necessary to reduce a crush fracture of a vertebra by hyperextension. Grounds for this claim consisted of evidence from cadaver dissections and the actual use of hyperextension in a series of thirteen consecutive cases.

Various types of hyperextension have since been developed. Hundreds, probably thousands, of fractures of the spine have been reduced by hyperextension during the past ten years. So far, evidence of damage from hyperextension is not forthcoming. Nevertheless, the fear of overhyperextension still possesses a number of capable and informed operators. Since all crush fractures—whether cervical, thoracic, or lumbar—with or without dislocation or neurological signs depend primarily upon the anterior longitudinal ligament for their reduction, since regardless of which of the number of eligible techniques is employed the use of the anterior common ligament is inescapable, and since fear, caution, and ignorance of the anatomical structures involved have led to distorted quotation of method and are now affecting the literature on the spine, it is imperative to know definitely what sort of use or abuse the main reducing factor, the anterior longitudinal ligament, can withstand.

This paper is based on the end results of 132 cases of fracture of the vertebral centrum seen during the past thirteen years. With but few exceptions, the foot-suspension method was used in all thoracolumbar cases. In all cases the anterior longitudinal ligament was regarded as the check to any possibility of overhyperextension. Misapprehension concerning the mechanics and anatomy involved have apparently led to unwarranted fears sufficient to interfere seriously with adequate reduction. It is, therefore, a matter of fundamental importance to know, if possible, the actual resistance of the ligament to imposed strain versus the amount of stress necessary to obtain reduction.

The difference between the minimal rupture point of the ligament and the maximal pull in pounds necessary to reduction will show the resulting safety factor. The other factor which it is important to know is the degree of elasticity. Since elastic yield would probably involve cord and root damage, it is important to record the actual elongation per unit of imposed strain.

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

The following is offered as evidence of the adequacy of the anterior longitudinal ligament to withstand with a large margin of safety the stress of hyperextension necessary to the reduction of crush fractures. The accompanying record also shows that the anterior longitudinal ligament is a practically non-elastic membrane, resembling, in its behavior under strain, the curve for the reaction of metals.

METHOD OF MAKING THE TEST

Coronal sections of the spine, including the anterior half of the centra of seven vertebrae in the region of the thoracolumbar junction, were removed from autopsy subjects as they became available. Sufficient bone and disc were removed to permit attachment to specially devised tapered, ringed, metal rods of an instrument known as a "Universal Testing Machine" in the General Electric Test Laboratory, Erie, Penn-

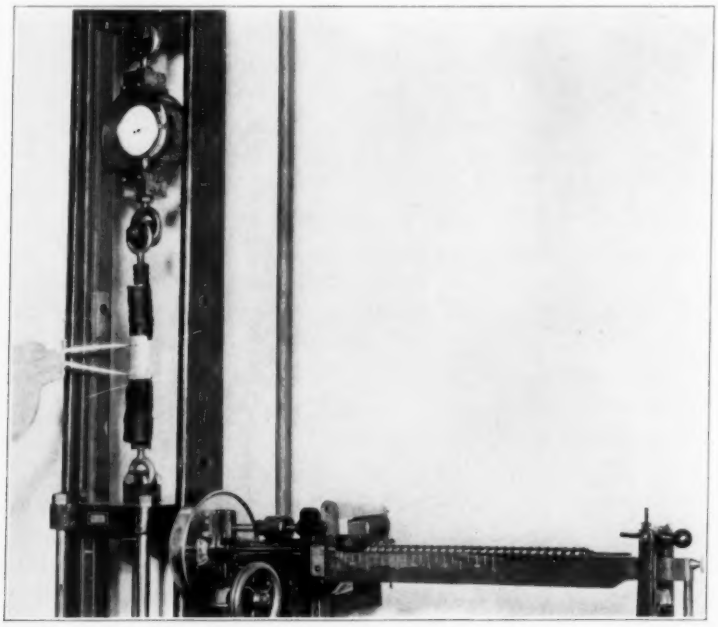

FIG. 1

Seven-vertebrae section mounted on "Universal Testing Machine". Calipers indicate dots used to determine stretch. (*Courtesy of General Electric Test Laboratory.*)

sylvania. (See Figure 1.) The remaining cortical shell, anterior longitudinal ligament, and intervening annulus fibrosus of the specimen were then lashed securely at both ends to the gearlike rods. Considerable difficulty was experienced in preventing the spine from slipping on the rods. By binding them tightly with successive windings of heavy cord, it was possible to give the sharp-edged rings or gears a firm bite into the remaining bony shell, thus preventing the attachments from slipping. The

cord windings were then covered with black tape. The rods were united with a telescoping rod introduced between the traction rods to maintain a vertical pull. No frictional resistance was introduced by the telescoping rod; therefore, no allowance is necessary for this factor. The section of spine remaining for test consisted of one vertebra and two discs.

Elasticity was determined by marking the specimen with India-ink dots two inches apart. Calipers recorded the spread of the marks at intervals of fifty pounds.

The testing of the first two specimens was unavoidably delayed for three days, during which time the specimens were kept immersed in salt solution and formaldehyde. Allowance must, therefore, be made for deterioration. The remaining five specimens were tested within from six to eight hours of removal.

RESULTS OF TEST

Table I shows the record of seven specimens tested as described. The average breaking point was 337 pounds. Two unusually strong specimens (C. H. and F. J.) are included. Two specimens (V. B. and J. G.) deteriorated; these subjects had been bedridden with longstanding illness. No specimens from females as yet have become available.

TABLE I

RESULTS OF TESTS OF ANTERIOR LONGITUDINAL LIGAMENT

Case	Age (*Years*)	Occupation	Illness	Duration of Illness	Yield in Two-Inch Section	Breaking Point (*Pounds*)
V. B.....	44	Molder	Occupational emphysema	5 years	.012 of an inch in 150 pounds	180
J. G.....	65	Unknown	Carcinoma of stomach	2 years		160
R. B.....	54	Lumberman	Bone sarcoma	6 months	.08 of an inch in 200 pounds	230
H. W.....	83	Unknown	Fracture at base of skull with cerebral hemorrhage	1 day		360
C. H.....	17	Athlete	Septicaemia	1 week	.02 of an inch in 200 pounds	550
F. J.....	27	Molder	Perforated duodenal ulcer	1 month		480
I. B.....	42	Machinist	Endocarditis	A few hours		400
Average...	47.5				.037 of an inch per 50 pounds over 150	337*

* The average breaking point, excluding the two delayed specimens, was 404 pounds.

The ligament parted in the mid-centrum in each case except in one in which it parted at the upper edge. Analysis of this exception forced the conclusion that in this case the mounting was at fault, since the break occurred at the edge of the cord lashing.

After three stretch determinations had been made, this part of the test was omitted because of difficulty in controlling the slipping of the specimen on the rod, the time of suspension apparently having to do with the firmness of the hold. It is realized that results from only three cases provide meager information; nevertheless, the findings in the three cases were surprisingly consistent.

In no case was a measurable yield recorded up to 150 pounds. From 150 up, the yield was of the nature of a straight line,—that is, an average of .037 in two inches for every additional fifty pounds above 150.

Against these determinations, the pull in pounds necessary to reduction was made on normal living patients of a body weight ranging from 150 to 225 pounds. In addition, a typical crush fracture of the first lumbar vertebra in a male weighing 165 pounds was reduced with the typical foot suspension regularly used to-day. (See Figure 2.) Chatillon balances were interposed between feet and suspension spreader. The records show a minimal pull of thirty pounds per leg and a maximal pull of forty pounds. Actual reduction required thirty-three pounds per leg, or a total of sixty-six pounds. Since the maximal pull required is eighty pounds and the minimal breaking strength 160 pounds, the safety factor is in the ratio of 2 to 1 at the lowest, 7 to 1 at the highest, and 4 to 1 as an average. The relative absence of elasticity indicates that duration of suspension has little if any effect in relation to yield of the ligament.

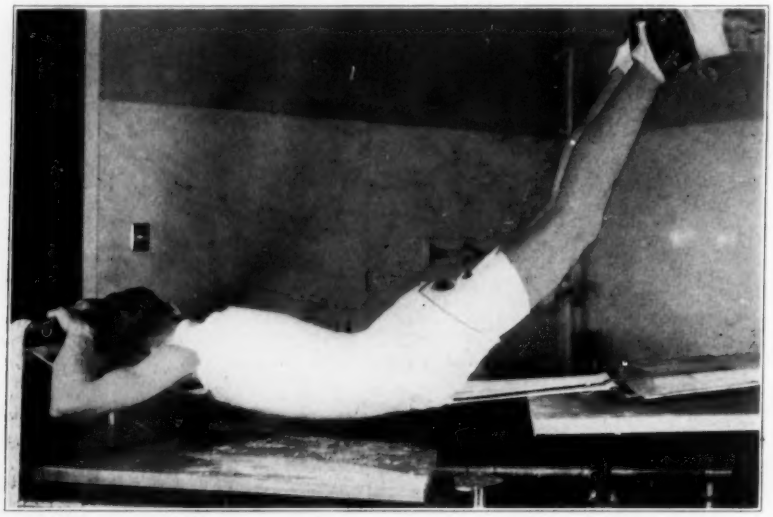

FIG. 2

Typical foot suspension and jacket as used for uncomplicated thoracolumbar crush fractures during the past eight years.

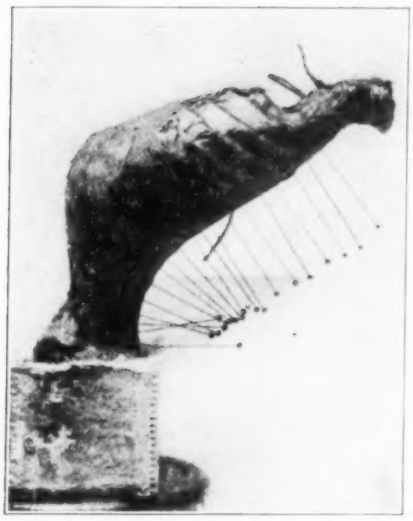

FIG. 3

Hyperextension in the cadaver. Normal hyperextension has the contour of a hockey stick. (*Courtesy of P. Blakiston's Son & Co.*[4])

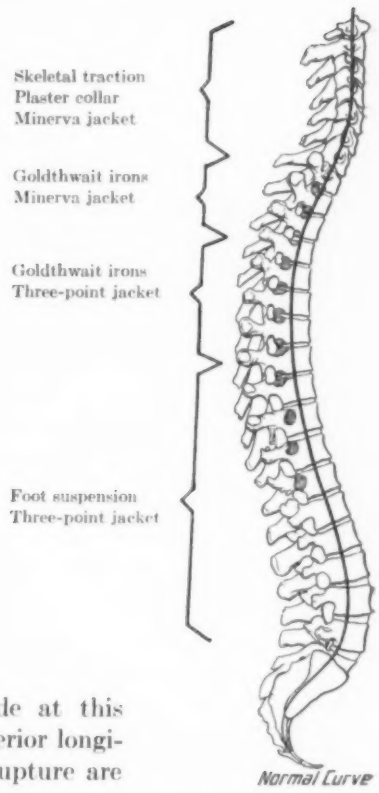

FIG. 4

Showing the several different methods of treatment used for simple uncomplicated crush fractures, depending upon the section of the spine involved. (*Courtesy of P. Blakiston's Son & Co.*[3])

Certain reservations must be made at this point. Conditions under which the anterior longitudinal ligament undergoes horizontal rupture are conceivably as follows: When sufficient shear stress is exerted to move the thoracic section horizontally on a fixed lower section (*e.g.*, coal mine cave-ins), or when the subject falls from a height back foremost, striking a projecting part at right angles to the spine, according to the tensile tests in such a case the vertebra would be expected to rupture in the mid-centrum and the ligament to rupture transversely. Such a case actually occurred. The patient was catapulted out of the car and landed across a railroad rail, but the ligament was not ruptured. He had a fracture-dislocation with paralysis. The spine was carefully hyperextended, and the patient recovered full function. This hyperextension cause of avulsion fracture is extremely rare, occurring only once in this series. The causative mechanism in this case is directly opposite to the usual flexion. The weight of both ends of the torso is levered sharply against the middle, which produces narrowly localized hyperextension. If the conditions are thus made sufficiently exacting, rupture of the midmost portion of the centrum and ligament may be expected. Such a conjuncture of conditions is, however, highly improbable.

In the case of the shear stress, if the patient lives, the cord has usually

been irreparably damaged by the same horizontal force, rendering all treatment futile. Many such fatal cases occur in mines, in heavy industries, and in mutilating car accidents.

OUTLINE OF TREATMENT

When the spine is normally hyperextended, it resembles in contour a hockey stick. (See Figure 3.) Methods of reduction should aim to simulate this curve. Variations in anatomy and flexibility alter the degree of curvature. When the pelvis swings clear, the 45-degree pull of foot suspension tautens the ligament regardless of flexibility or anatomical variations. It is useless to attempt to extend all parts of the spine equally. The thoracic section merely acts as a fixed point against which the lumbar spine is levered. The thoracic spine is relatively immobile. The following outline is based essentially on foot suspension except for high thoracic and cervical fractures. (See Figure 4.) It depends upon a taut ligament for restoration of form.

Fractures of the Lumbar and Lower Thoracic Vertebrae

1. Give first-aid treatment. Roll the patient into the prone position at the site of the fracture.
2. Take an x-ray.
3. Make a neurological examination; if there is nerve involvement, make a careful analysis. Individualize treatment as outlined under discussion.
4. If there are no paralytic symptoms, reduce the fracture immediately by the foot-suspension method, and apply a three-point-pressure jacket extending from the clavicle to the pelvis. Do not give an anaesthetic or any narcotic.
5. On the next day take a check-up roentgenogram. If this shows insufficient reduction, remanipulate, using thrust if necessary.
6. Take another check-up roentgenogram.
7. Keep the patient recumbent for six weeks, free to change position, but not to sit up.
8. Then shorten the jacket, or, if there has been loss of weight, change the jacket. Again check the results roentgenographically.
9. Allow the patient to be ambulatory for six weeks.
10. Remove the jacket and take a careful detailed Bucky x-ray. Warn the patient at this time against lifting heavy weights in the stooped position. Give postural exercises to develop the abdominal muscles.

Fractures of the Intermediate Thoracic Vertebrae

The same sequence obtains in fractures of the mid-thoracic vertebrae except that Goldthwait irons are used instead of foot suspension.

Fractures of the High Thoracic Vertebrae

These fractures also are reduced on Goldthwait irons. A Minerva jacket is immediately applied. The torso is supported by the irons; the

head, shoulder, and neck section meanwhile is allowed to sag of its own weight off the ends of the irons. The Minerva jacket, including head and neck as it does, is necessary to retain the reduction. Obviously the head requires just sufficient support for comfort of the patient during application of the jacket. The reduction is accomplished through gravity of the head, neck, and shoulder girdle against the fixed thoracic spine.

Fractures of the Cervical Vertebrae

1. Roll the patient on his back, with padding under the neck.
2. Send the patient on a stretcher directly to a hospital bed. Apply halter traction with the spine in hyperextension, using a five-pound weight. Elevate the head of the bed.
3. Make a neurological examination.
4. Take an x-ray, using a portable machine.
5. Make the Queckenstedt test if symptoms indicate the need of it.
6. Decide whether conservative treatment or laminectomy shall be used.
7. Apply skeletal traction or a plaster collar immediately, depending on the condition of the patient.
8. Check neurological status at intervals.

Where the intervertebral disc appears to be involved in a spinal fracture—that is, where the intervertebral space is definitely narrowed—rupture into the vertebral substance or subdural space is suspected. This factor affects the sequence of treatment. If neurological signs cannot be explained by fracture, the disc is held responsible until some other factor is proved to be the cause. In the absence of neurological signs, the nucleus is assumed to have escaped through a fissure or bone space. It is thought that the element of traction contained in foot suspension may mitigate the vertebral atrophy which follows such lesions. No typical bone atrophy has been found in the series presented.

DISCUSSION OF TREATMENT OUTLINED

Contrary to recent citations in the literature of foot suspension, no roentgenogram is taken during the suspension; nor is the patient watched for symptoms or signs of impending paralysis or root pressure. There has been no reason for this precaution. No anaesthetic is used. No opiates are ordinarily used. In cases where immediate reduction by foot suspension is contra-indicated—where prohibitive complications such as shock, cerebral involvement, or multiple fractures interfere—the spinal fracture is extended or partially extended on a frame, not hyperextended, or the patient is kept prone with permission to raise himself on his elbows until he becomes eligible for adequate treatment.

Where laminectomy appears to be indicated, shells are first applied with the spine in hyperextension for cases of thoracolumbar fracture; bivalved plaster collars are used in cases of cervical fracture. A number of the patients in the author's series have recovered from varying degrees

TABLE II

END RESULTS IN 115 CASES FOLLOWED UP DURING PAST SIX MONTHS

Type of Fracture	Cases Treated	Returned to Former Occupation	Residual Symptoms Present	Died
Odontoid process	3	3	0	0
Cervical vertebrae	27	21	3	7
Thoracic vertebrae	19	17	2	2
Lumbar vertebrae	66	63	2	2
Total	115	104	7	11

of partial paralysis. Two patients with complete paralysis of the cervical spine have also recovered. One recovered completely; another with very slight spastic leg signs of a permanent nature recovered sufficiently to return to his former occupation.

It is becoming increasingly clear that hyperextension is a better decompressor than laminectomy for the reason given before,—namely, that hyperextension increases all diameters of the intraspinal space by removing the impinging bone at the site of the fracture.

CONVALESCENT CARE

Roughly, in from three to four months there is a return to former occupation in unparalyzed cases regardless of whether the fractures are cervical, thoracic, or lumbar. In those cases where the occupation is sedentary or very light, the patient returns to work, if work is possible in a jacket, in from two to three months. These periods are necessarily somewhat arbitrary for the reason that sufficiently firm callus cannot be readily exhibited roentgenographically. Tenderness on deep percussion over the involved centrum is a more dependable criterion. There is no tenderness in a completely recovered case.

The reason for six weeks of recumbency is mainly that which pertains to fractures of all other parts of the body. According to the general rule, physiological rest is guaranteed by recumbency in a jacket which permits a change of position in the horizontal plane, but disallows sitting or standing. Allowance is always made for the possibility of fractures of the accessory processes whether or not roentgenographic proof is present. While Mensor and others have shown these fractures, they are ordinarily not subject to exposition; therefore, they must be assumed to be present but hidden by the dense overlying cortical shadow. When present, the imposition of body weight above the fracture induces shear stress with the possible sequelae of excess callus and pressure radiculitis.

It is considered important to institute ambulatory treatment at the end of six weeks. Again by analogy, it is assumed that bone differentiation has occurred. The vibrational influence of walking [1] then serves to

TABLE III

ANALYSIS OF SEVEN CASES WITH RESIDUAL SYMPTOMS

Type of Fracture	No. of Cases	Symptoms	Remarks
Thoracic vertebrae	1		Wedged vertebra. Restricted to work as salesman.
High thoracic vertebrae	1	Unable to raise both arms forward simultaneously.	Returned to work as secretary.
Lumbar vertebrae	2	Lameness of back (1).	
		Weak back (1).	Returned to former occupation.
Cervical vertebrae	3	Pain in neck and shoulder (1).	
		Slight anaesthesia in clavicular region (1).	
		Partial numbness in lower extremities (1).	

induce the necessary perpendicular structural trabeculations for unrestricted weight-bearing. The difference in stress lines between the roentgenograms at the end of six weeks and three months is evidence of this point. There have been notable exceptions to the above rule of thumb. A few unruly patients have gotten up shortly after the initial reduction, have continued otherwise under treatment, and have suffered no penalty. The explanation for this is well known. The posterior arch bears all the weight in a properly hyperextended, well-fitting jacket. Corpulence, loss of weight, and arch fractures are the chief reasons which deter us from earlier activity.

END RESULTS

Table II shows the end results in 115 cases which have been followed up during the past six months. One hundred and four patients recovered and eleven died. Of the 104 patients, forty-three were day laborers or did heavy work; thirty-three did light or sedentary work; and twenty-eight were housewives. Seven patients recovered with residual symptoms as shown in Table III. Of the eleven fatal cases, seven were fractures of the cervical vertebrae and the patients died shortly after fracture; two were fractures of the thoracic vertebrae and death followed shortly after fracture; two were fractures of the lumbar vertebrae and the patients died six months and one year after fracture. At autopsy destruction of the cord was found in six cases of fracture of the cervical vertebrae and in one case of fracture of the lumbar vertebrae.

During the thirteen-year period in which the 132 fresh crush fractures were seen, injuries to the intervertebral disc were found in fourteen cases. Fusion was done in six of these cases with a questionable result in one case.

Thirty cases of old fracture with disabling symptoms, which had been treated by others, were also seen. Fusion was done in thirteen of these cases. Several of these patients had some residual disabling symptoms following the fusion. Most of them, however, have returned to their former occupations without disability. No exact analysis of end results in these fused cases has been attempted.

SUMMARY

There is more certainty regarding return to former occupation in the average uncomplicated crush fracture than there is in the case of fracture of a long bone. Reductions are more complete, union more certain, and malunion well nigh impossible. There is no threat of soft-part interposition.

At present the complete treatment of a simple crush fracture is less time-consuming and involves less work than most long-bone fractures. Present practice allows the dependable patient to leave the hospital in a day or two to spend six weeks recumbent at home. Three or four after-calls suffice to restore him to his former occupation. This sequence is rapidly becoming average.

Tensile-strength and elasticity tests indicate competence of the anterior longitudinal ligament far beyond the necessary strength required for reduction by hyperextension. Additional proof of adequacy is afforded by the 132 cases in which reduction was accomplished without evidence of damage.

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CELLULOSE-COMPOUND CASTS USED IN THE TREATMENT OF ARTHRITIS *

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A light-weight, durable, waterproof cast, which will transmit x-rays without obscuring shadows, has long been desired to replace plaster-of-Paris. Fortunately, a recent discovery [1] has made available to the medical profession a cellulose compound long used in industry. A very convenient product is now available in the form of a roll of unbleached cotton sheeting, cut on the bias in two-inch and three-inch widths, ten yards long, impregnated with solvent, and contained in a hermetically sealed can ready for instant use.

Briefly summarized, the physical and chemical properties of this compound belong to the realm of colloidal chemistry in contrast to crystallization of plaster-of-Paris. Boric acid and a safety type of pyroxylin, containing only 12 per cent. nitrogen dissolved in acetone, form the adhesive constituents. When the acetone has evaporated, the hard cast is no more inflammable than wood. It is much safer to handle when wet than collodion.

Although when applied to the bare skin no irritation has been observed, usually the cast is applied over a layer of stockinet or sheet wadding. Hardening is slower than it is when plaster-of-Paris is used, but after forty minutes the cast is quite firm. Drying may be facilitated by using an ordinary radiant-bulb lamp and plenty of ventilation. Very little objection to the odor of acetone, which disappears with drying, has been expressed by any patient. Although rubber gloves are usually used by the operator, they are by no means necessary, since a little petrolatum on one's hands prevents the bandage from sticking to the fingers. Attention must be called to the fact that, if the cellulose-compound bandage is stretched and applied tightly, there will be a certain amount of shrinkage upon drying, but this shrinkage is not appreciable if the bias bandage is carefully applied without its width being narrowed. Also, cylinders tend to curl slightly unless an even number of layers are applied with alternate layers reversed.

Because of certain outstanding advantages over plaster-of-Paris—mainly lightness in weight and some resiliency—forty-two cellulose-compound casts have been applied on twenty-four patients with arthritis, with results which were favorable beyond expectation. A desire to have all plaster-of-Paris casts replaced by cellulose-compound casts was quickly sensed in the wards of arthritic patients soon after one or two

* Read before the Boston Orthopaedic Club, January 10, 1938.

FIG. 1

Demonstrating the amount of correction obtained by cellulose-compound cast at the end of three weeks.

patients experienced the change in their retentive apparatus. This cast has been employed in treating all kinds of arthritis with consistent approval of its use in each type.

For example, in rheumatoid arthritis in those patients under treatment for correction of deformities after the acute stage of the disease had become quiescent, where plaster-of-Paris had been tried numerous times unsuccessfully, cellulose-compound casts were tolerated with much less discomfort. The most outstanding example of this occurred in a young woman, twenty-four years of age, whose rheumatoid arthritis had begun at the age of twelve years. On admission to the hospital, examination revealed involvement of practically every joint in the body. She had flexion deformities of both knees. Plaster-of-Paris cylinders had been applied several times for the purpose of correction. Each time, the patient complained of such severe discomfort that, during her three-year stay in the hospital, she could not tolerate any plaster cast on her legs for over fifty-six hours at a time. On November 11, 1937, two cellulose-compound cylinders were applied to the lower extremities. After four days, these casts were cut back of the knees in such a way that throat sticks could be used for wedging the cast open posteriorly. The patient stated that she was able to move about with less discomfort with them on than off. At the end of three weeks, twenty-six throat sticks had been inserted back of each cylinder (Fig. 1). At that time the cylinders were removed and new ones were applied. Wedging was started again. After four

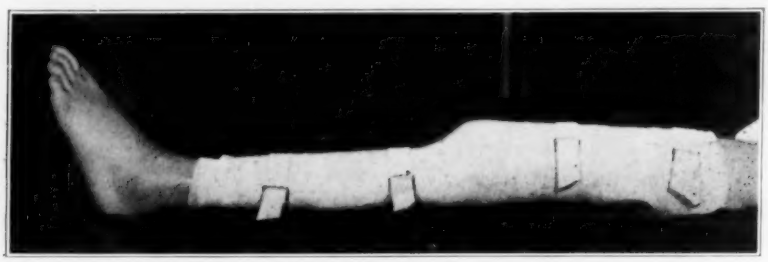

FIG. 2

Cellulose-compound cylinder applied after the left knee had been extended.

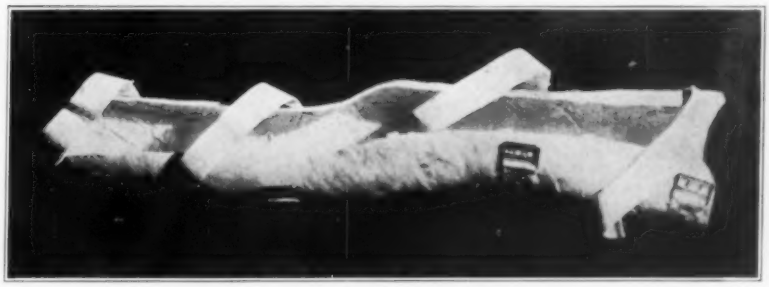

FIG. 3

Cellulose-compound cylinder shown in Fig. 2, removed to show detail. Note the extreme thinness. A longitudinal strip, the width of the patella, has been cut out anteriorly.

weeks more, the knees were completely extended. The patient stated that she could tolerate these casts because of their extremely light weight which allowed her to move about freely in bed, whereas the plaster-of-Paris casts had always been so heavy that she had never been able to move about without assistance.

In the treatment of both bed and ambulatory patients with arthritis, cellulose-compound cylinders have proved a very valuable adjunct to physical therapy. A patient who was bedridden with rheumatoid arthritis had ankylosis of both hips and of the right knee in such a position that he was unable to sit or to stand. Arthroplasties of the left hip and knee were performed. Physical therapy was started in the Hubbard tank as soon as the wounds had healed, but the patient complained of severe pain in the left knee joint. Therefore, all active motion had to be stopped until a cellulose-compound cylinder was applied (Figs. 2 and 3). With this waterproof, light-weight support, painless exercise under water was carried out regularly and effectively (Fig. 4). Within a few weeks' time a

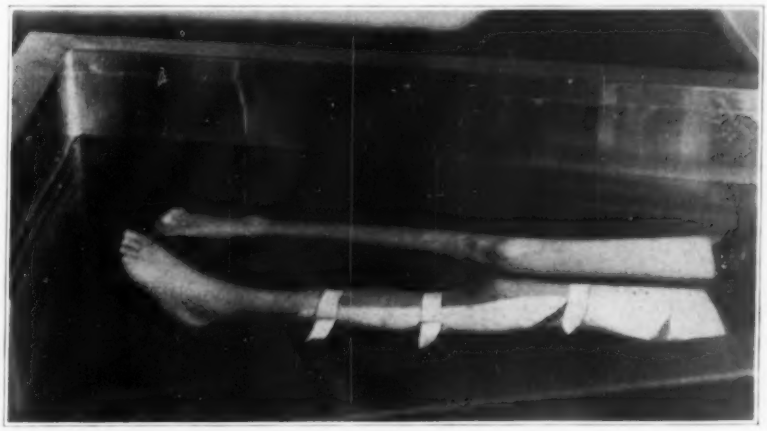

FIG. 4

Demonstrating the actual use of the cellulose-compound cylinder for underwater exercises in the Hubbard tank.

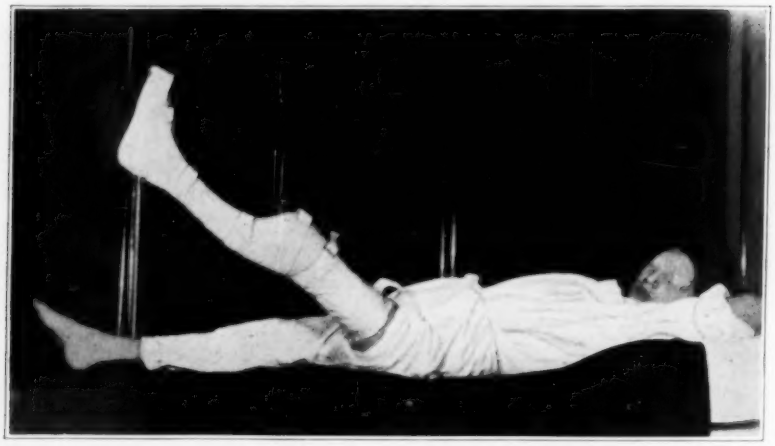

FIG. 5

Showing the ease with which the patient can lift the leg and cast against gravity.

partial weight-bearing walking caliper was fitted. The patient was then able to begin walking again after a lapse of ten years. He wore the cellulose-compound molded cylinder inside his walking caliper.

FIG. 6

Anterior view of a pair of cellulose-compound walking cylinders. Note the neat appearance which is made possible by the elasticity of the material which permits it to conform to the parts to be protected.

In a case of septic arthritis of the knee with secondary osteomyelitis, it seemed impossible to apply a plaster-of-Paris cylinder which would last more than a few days before it would become contaminated, discolored, and malodorous from the profuse discharge. Nevertheless, a plaster-of-Paris cast was made, using steel bars to form struts over windows necessary for dressings. This arrangement was so cumbersome and heavy that the patient had to lift his leg with his hands whenever he moved in bed until a cellulose-compound cylinder was substituted. The patient was delighted because of the ease with which he could move about with the use of his own leg muscles. The cast was cut down the center of the front (since bivalving is unnecessary with such elastic material) to permit its occasional removal for dressings. It did not absorb purulent, malodorous sinus discharges, and it did not become boggy and soft. The patient would very proudly lift his leg into the air to demonstrate his new achievement, and incident-

ally benefited by this exercise (Fig. 5). After wearing this cast for four weeks, the patient was permitted to start walking with a non-weight-bearing Thomas-band walking splint with a patten bottom. With this splint he also wore a light-weight walking cylinder of cellulose compound, which gave adequate protection to the sensitive knee joint.

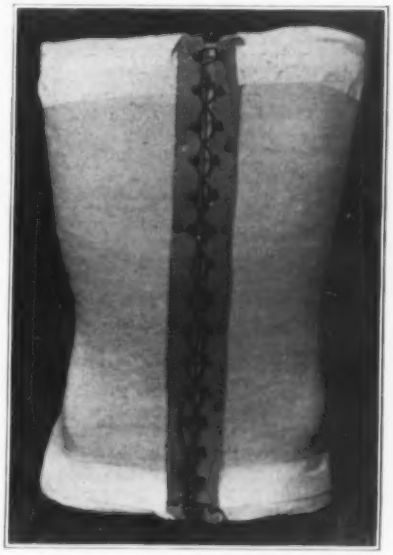

FIG. 7

Cellulose-compound jacket with a strip of hooks bradded on either side to facilitate lacing.

In treatment of aged patients with osteo-arthritis, and likewise in the treatment of ambulatory patients with arthritis of the knees whose joints are quiescent when the patients are recumbent but become swollen and painful on attempted walking, so-called walking cylinders have been used with excellent results. Previously, molded plaster-of-Paris posterior slabs were used which were similar in shape to so-called "ham" splints. Such splints, however, gave relatively little support to the lateral ligaments of the knee joint as compared with the new cylinders depicted here. The resiliency of the cellulose-compound cylinder permits removal and reapplication without destroying the shape and accurately fitting qualities. Furthermore, the cylinders easily remain in place and do not slide down onto the ankles of the patient during walking (Fig. 6). The actual weight of each of these casts, complete with buckles and straps, is about ten ounces.

From the standpoint of economy, in the treatment of Strümpell-Marie arthritis involving not only the spine but rib articulations, shoulders, and hips, cellulose-compound jackets, constructed over a torso such as is used for the making of molded leather jackets, can be furnished for about one-quarter of the cost of the leather jackets. (See Figure 7.) The molded, tempered back steels can be incorporated in the cellulose-compound jacket just as in a leather one. The finished product is not only much thinner, lighter, and cooler, but it tends to hold its shape better because it is tougher and will not deteriorate after excessive perspiration in hot weather. Incidentally, one of our patients had a rather marked structural scoliosis as well, which also received some support from this jacket.

Futhermore, when a Böhler walking iron is incorporated in a cellulose-compound cylinder, the iron does not rust, but remains suitable for use on another patient.

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THE NEUROLOGICAL ASPECTS OF INJURIES TO THE SPINE *

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It may be granted at once that destructive damage to the spinal cord cannot be repaired, that no regeneration occurs, and that destructive lesions are in no way amenable to surgery. A number of pertinent questions, however, may be asked, although there may be some debate over the answers. For example, one may inquire whether the factor of continuing compression of the cord by displaced bone is important, and particularly whether or not the relief of such pressure will aid in restoring function. Again, in the presence of displaced vertebrae, particularly in the cervical region, with evidence of complete interruption of function in the cord, is it possible that restoration of the normal alignment of the spinal canal will permit any return of function? If there is evidence of an incomplete lesion of the cord, can surgical intervention minimize the effect of the injury and permit a better outlook for the future? How often is hemorrhage a factor in causing paralysis? If intra-medullary hemorrhage is present, what can be accomplished by surgery? Under what conditions is surgical intervention desirable?

These are some of the questions which recur. The writer does not believe that answers by neurological surgeons of experience would vary widely, although there is little doubt that earlier in their careers most of them were much more optimistic about the possibility of accomplishment by operative treatment than they became later. In general, any very great enthusiasm for operation in more than a small percentage of cases is confined to the less experienced. In this regard, the author is not speaking of injuries to the lower spine, below the level of the first lumbar vertebra, in which the situation is altogether different. There we are dealing with nerves of the cauda equina, below the level of the spinal cord.

Actual compression of the spinal cord arises from narrowing or distortion of the spinal canal, or enlargement of the cord itself from intramedullary hemorrhage or swelling. In such instances it is generally felt that maximum recovery of the cord cannot be expected unless this compression is relieved. Possibly there is an element of truth in this statement. Usually, however, there seems to be an entirely unwarranted optimism as to the possible accomplishment. Continued compression of the cord can conceivably cause a local ischaemia and produce secondary changes in addition to those primarily caused by the trauma. In a cord which has been damaged but not destroyed, can continued pressure produce further changes? In this connection, the writer believes that an

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

analogy can be drawn between the brain and the cord. In the experimental laboratory some time ago we conducted a large number of animal experiments in which the effects of localized pressure on the brain were studied. In these animals localized compressions of the brain were produced in various ways. In one series localized depressed fractures were caused by means of a regulated blow; in another series depressions of an equal depth were produced at operation by the insertion of a small object between the dura and the brain, without subjecting the area to a blow. These experiments led to the unmistakable conclusion that the pathological changes associated with these localized lesions arose from the manner of their production rather than from the lesions themselves. Whatever pathological changes were present in the brain were caused by the force of the original trauma. Localized compression produced in such a way that there was no immediate damage to the brain, even though such pressure continued for a long time, produced no pathological alterations other than a condensation of tissue, which promptly returned to normal when the compression was relieved. Continued pressure upon a localized area of the brain did not lead to permanent circulatory changes, degeneration, cystic formation, or any other discoverable process. While, so far as the author knows, similar experiments have not been carried out on the spinal cord, it is not easy to give credence to the idea that a compression, the result of an acute displacement, would be likely to cause symptoms of compression of the cord. It is far more probable that organic damage to the cord was caused by trauma at the time such displacement occurred. While there may be other good and sufficient reasons for securing a reposition of the vertebrae, one should not expect that this procedure will materially influence the signs that indicate faulty function of the spinal cord.

If we are correct in assuming that neurological disturbances following injury to the spine are caused by organic alterations in the cord, rather than by blocking of physiological impulses from pressure on the cord, under what conditions may surgical intervention be helpful? First, let us consider that group in which function of the spinal cord is completely lost below the level of the injury.

Recently, and deservedly, much has been written on the handling and transportation of the patient who has just received an injury to the spine. When such a patient enters the hospital, the first consideration is to determine the presence and severity of the injuries to the spinal cord and its nerves. The picture of complete paralysis from injury to the spinal cord is well known, and the flaccid paralysis, absence of reflexes, deep sensory loss, and paralysis of the sphincters are readily determined. If the motor paralysis is complete and the reflexes are lost, the briefest of examinations will determine the upper limit of the sensory paralysis. Below this upper level we wish to know if the sensory loss is complete. If the examiner will step to the foot of the bed and forcibly flex one of the patient's toes and compress it in such a manner as to cause severe pain, and if the patient

perceives no sensation whatever, the sensory loss may be considered to be complete, for otherwise deep sensibility and sense of pain would remain. If the patient perceives some sensation from this test, the interruption of the cord is incomplete. This we consider the most practical and informative part of the sensory examination. When the sensory loss is incomplete, a more detailed study is required.

Given complete interruption of function, the question may be raised: "Is this caused by complete division of the cord, or may it arise from a physiological interruption which may be temporary and dependent upon such factors as contusion and hemorrhage, much of which may resolve and permit a return of function?" In this connection, the writer may say that he has yet to see a patient who exhibited a flaccid paralysis with an absolutely complete motor and sensory loss and paralyzed sphincters, which persisted for twenty-four hours after injury, show recovery other than that limited to a few segments about the level of the injury. Additional information is gained from roentgenographic studies of the spine, both anteroposterior and lateral projections. Occasionally the deformity may be so great as to indicate a complete shearing off of the intraspinal structures. Spinal puncture will determine the presence or absence of blockage of the spinal canal, although in the writer's experience, when there is clinical evidence of complete interruption of the cord, this test has not led to improvement in the treatment of these severely injured patients. Given such a picture, the patient's comfort and the prevention of such complications as decubitus and urinary infections, are particular responsibilities. The author believes that proper use of an air mattress, inflated just sufficiently to permit its ready conformation to the contours of the patient, is of the greatest aid. With the patient on an air mattress, the knees may be moderately flexed with several pillows beneath them, giving support under the lower half of the thighs, the knees, and along the calves down to the ankles. The extremities should be so supported that the heels clear the bed, and pressure sores upon them can be avoided. A cradle over the lower extremities to sustain the weight of the bedclothes is in order, and a lamp may be provided, if necessary, to maintain the proper temperature. With such an arrangement, clean dry sheets which are kept smooth, and the use of alcohol and camphor on the skin, the patient can be adequately protected against bed sores. In our experience, catheterization and indwelling catheters, even under the best conditions, do not prevent infection of the urinary tract. The writer believes that there can be little doubt that suprapubic cystotomy with drainage is the procedure that has most to recommend it.

The skeletal injury receives the next consideration. Fixed rules cannot be laid down, and generalizations are difficult. If the severity of the injury to the cord is fully appreciated, it is obvious that the treatment of the skeletal injury itself should have as its goal the future comfort of a paralyzed patient rather than the more ambitious aim of restoring the skeletal structures to a condition satisfactory to a person who would

later be ambulatory. It may be mentioned here that complete lesions of the cord, particularly from injuries to the thoracolumbar spine, may be compatible with indefinite periods of life and a self-supporting economic status. The author has a number of such patients who have properly arranged wheel chairs and seating arrangements, and are carrying on the occupations of watch-maker and jeweler, stenographer, and radio repairer. In this group of patients, the recognition of the severe nature of the injury, treatment designed to spare them complications, and the proper handling of the psychological situation, with an early effort to restore to them some earning capacity, are the factors which we should emphasize.

Although the subject of cervical injuries will be covered by others, the writer would like to indicate here that the complete cervical injuries are so grave and the expectation of life is so short that the plans which apply to patients with injuries lower in the spine are not applicable.

Let us next consider the group of spine injuries in which varying degrees of impairment of nerve function are present, without complete paralysis. Given a spine injury with incomplete paralysis, it has been our experience that the improvement which the patient shows is usually far greater than might have been surmised at first, and that this improvement continues over a surprisingly long time. Perhaps many of the enthusiasts for operative treatment have formed their judgments from contact with these incomplete lesions and have attributed a striking improvement to the activities of the surgeon rather than to the natural processes active in repairing contused tissues. Certain factors are used as guides to treatment in injuries at various levels of the spinal cord, leaving injuries to the cauda equina out of consideration. If the motor and sensory paralyses are incomplete, the earliest observations of the patient should be thorough and detailed. Signs which are altering and paralysis which is increasing lead to very different judgment as to treatment than if such signs are stationary or showing a tendency to regress. Spinal puncture, with the determination of the presence or absence of blockage in the canal, is in order. Surgical procedures of one type or another are far more often required than in the complete lesions previously described. In the cervical region, this incomplete damage to the cord frequently manifests a predominantly unilateral injury, with a Brown-Séquard paralysis and an associated injury to roots of the brachial plexus. It is our feeling that, in these cervical injuries, restoration of the alignment of the vertebrae and restoration of the spinal canal are to be undertaken. Although our experience with such traction is very limited, it would seem that skull traction by some such method as that devised by Coleman and Crutchfield is mechanically the most advantageous and satisfactory. The use of a head halter has not met with any high degree of enthusiasm either on the part of the patient or of the surgeon, and is certainly trying and unsatisfactory. The helpfulness of a direct attack on the cervical cord by laminectomy may be seriously questioned. This

operation may be desirable in rare instances in which the spinous processes or laminae themselves need removal, but helpful intradural procedures would be most unusual to say the least. Exception may be made when there is evidence of increasing paralysis. At lower levels in the spine, patients in whom incomplete lesions of the cord show increasing signs should be operated on. Compression of the dural canal by injured laminae should be relieved. If there is blockage of the spinal canal, as indicated by the Queckenstedt test, we believe that operation is in order, even though the signs of paralysis are not increasing; laminectomy, opening of the dura, and treatment to be determined by the conditions found should be carried out. It is in this group that careful consideration of and appropriately directed treatment for the skeletal condition itself, either by bone graft or by more conservative measures, is in order.

If neurological signs are present in injuries of the lumbar spine, either with or without evidence of a complete lesion, it has been our practice to advise laminectomy at as early a time as the general condition of the patient will permit. Although in injuries of the first lumbar vertebra the tip of the spinal cord—the conus medullaris—may be irreparably damaged, the nerves of the cauda equina should be put in the best condition to permit a return of function. We have had the experience of having patients who have been brought to us with injuries of the lower lumbar spine, in whom the earliest neurological findings had indicated incomplete damage, show progressive neurological impairment and, at the time of laminectomy, we have found the filaments so matted together by scar and adhesions that little could be accomplished by the surgeon. We believe that earlier attention would have prevented such a matting together of the filaments and permitted a better outlook.

In summing up the factors which influence one's surgical judgment, certain points may be emphasized:

It is of primary importance to determine the completeness of the neurological lesion. With evidences of a complete lesion which persist for twenty-four hours after injury, surgery is probably of no benefit and permanent paralysis is expected.

In incomplete lesions combined with evidences of obstruction of the spinal canal, appropriate measures should be instituted to restore the spinal canal or laminectomy should be done to remove pressure.

Judgment of the patient's future as regards paralysis is necessary before any decision can be made. With an outlook for permanent paralysis, the need for any major surgery is most infrequent.

AN ACCESSORY TABLE TOP WHICH ELIMINATES GUESSWORK FROM EXTRA-ARTICULAR INTERNAL FIXATION OF FEMORAL-NECK FRACTURES

BY E. W. CLEARY, M.D., SAN FRANCISCO, CALIFORNIA

When the author first undertook to do internal-fixation operations with the thigh in a position of right-angled flexion,[1,2] he was impressed by the lack of an effective mechanism for holding the limb in this position. He then undertook to devise a mechanism which would serve this purpose. The accessory table-top assembly, which is the result of this endeavor, has passed through a series of models and changes over an interval of several years. It has been used for twenty-five or more fixation operations. Its use greatly facilitates the operation, shortens the operating time, and gives the surgeon accurate guidance as to point of insertion, direction, and depth in the placement of the internal-fixation device, whether it be bone graft, screw, single or multiple nail, or locking bolt. The simplification and standardization of x-ray technique effected by the mechanism not only minimizes the strain on the patient, but lessens the tax on the time and patience of the surgeon, the roentgenologist, and the operating-room staff.

The device enables the surgeon to accomplish secure and accurate fixation by bringing precision and accuracy into three steps of the operative procedure. It provides for:

1. Secure immobilization of the reduced fracture of the hip in traction in a position of right-angled flexion of the thigh and in any degree of rotation and abduction or valgus desired.

2. Accurate x-ray localization in vertical and horizontal projections of the position of the fractured femoral neck and head with respect to the table top over which the hip is held immobile.

3. Accurate and easy transfer of the localizing information supplied by the roentgenograms into the aseptic field of operation.

DESCRIPTION OF THE APPARATUS

A traction leg holder (Figs. 1,*A* and 3,*A*) is fixed to an x-ray permeable table top (Fig. 1,*B*) which has a cassette tunnel (Fig. 1,*C*). A lifting disk (Fig. 3,*D*), acting on the inner threaded shaft of the leg holder (Fig. 3,*E*), supplies the desired amount of traction. The degree of valgus increases proportionately to the extent that the buttock on the injured side is lifted. The leg, tied in the holder, is placed in the desired rotation and, after sufficient traction has been applied, is locked by a turn of the locking disk (Fig. 3,*F*). This accomplishes the first step.

Directing guides (Fig. 1,*G* and *H*) indicate the position of the tube center and the direction of the ray for horizontal (Fig. 4) and vertical (Fig. 5) views.

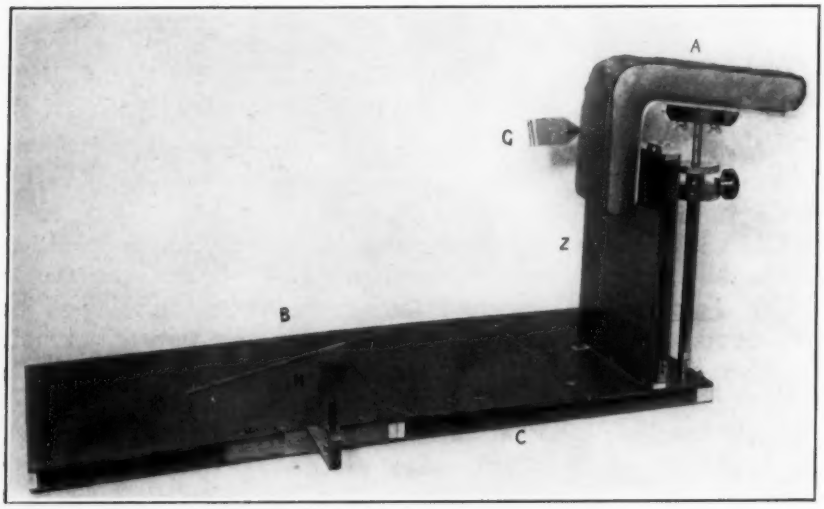

FIG. 1

A: Leg holder
B: Table top
C: Horizontal cassette tunnel
Z: vertical cassette tunnel
G and *H:* Directing guides for the x-ray

Plotting fields, of a substance which is not permeable to the x-ray, laid out on the intervening surfaces of the cassette tunnels appear on the negative as shown in Figures 4 and 5. In addition to the lines which form one-inch squares, there are lines laid out at angles of 10, 20, and 30

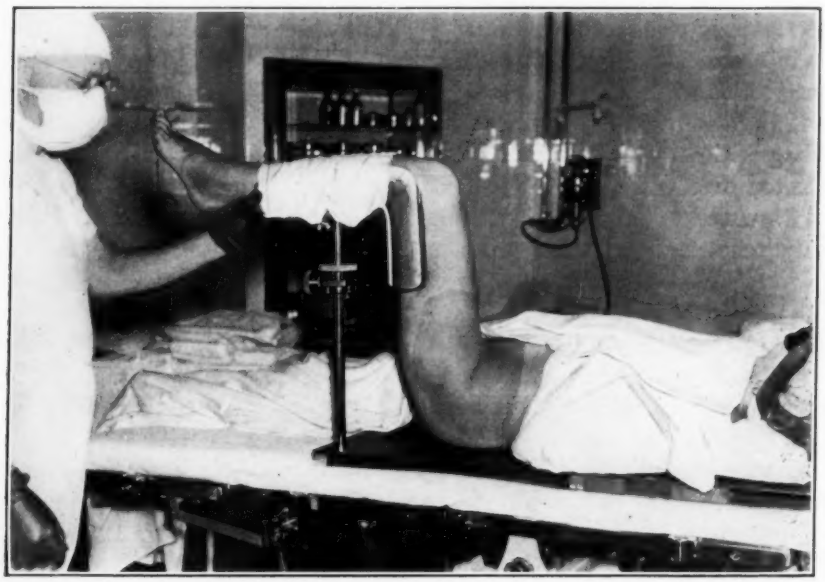

FIG. 2

Hip in position and immobilized after local anaesthetization and manipulative reduction.

degrees, so that the angle at which the central axis of the neck lies in relation to the double center line of the plotting field, or its parallels, is directly indicated. Superposition of the shadow of the bone over the shadows of the localizing plotting fields provides accurate localization, thus accomplishing the second step.

FIG. 3

A: Leg holder
D: Lifting disk
E: Threaded inner shaft
F: Locking disk
O and *P:* Pointer head
L: Horizontal metal plate
M: Pointer instrument
N: Pencil
R: Post
S: Base plate
T: Slide
U: Locking screw
Y: Sterile shield

There are three sterilizable parts utilized in carrying out the final step: a post shield (Fig. 3,*Y*), a horizontal plate (Fig. 3,*L*), and a pointer instrument (Fig. 3,*M*). The post shield provides a sterile cover for the post of the leg holder. The horizontal plate locks securely to the table top, providing a large sterilized surface. Over the central portion of this plate the base of the pointer instrument slides in a slot. It may be positioned and locked, with its center in the vertical plane in which the axis of the femoral neck is shown by the horizontal roentgenogram (Fig. 4). The pointer instrument (Fig. 3,*M*) is slid into position after the lateral surface of the trochanter is exposed through the incision. This pointer instrument consists of an adjustable post mounted vertically in the center of the base plate (Fig. 3,*S*). The head of this instrument is composed of two graduated disks, so mounted and attached to the vertical post *S* that a pointer pencil (Fig. 3,*N*), sliding in a channel in the head, can be adjusted at whatever level and angle are desired to "find" for the surgeon the position and direction of the central axis of the neck of the femur.

The radial graduations on the vertical and horizontal disks, like the angle lines of the localizing plotting fields shown in the roentgenograms, indicate 10, 20, and 30 degrees in the horizontal or vertical views, so that the surgeon may, by reference to the roentgenograms, very quickly and easily set the pointer pencil to mark the spot where the central axis of the neck passes through the trochanteric cortex. Having marked this spot on the bone with drill or chisel, the operator may then make a second adjustment of the disks, so that the pointer pencil exactly parallels the axis of the femoral neck. When this second adjustment has been made,

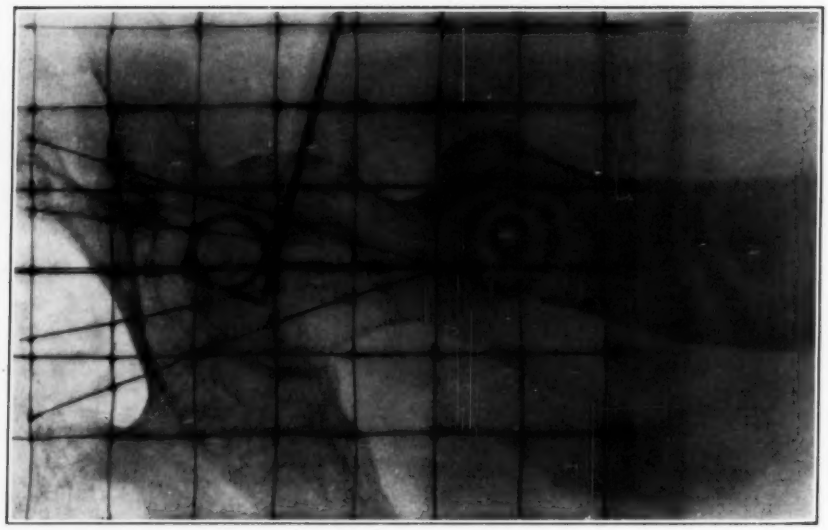

FIG. 4

Horizontal roentgenogram. This view, due to the flexed position of the thigh, gives the so-called "lateral" presentation of the femoral head and neck. Line shadows of the localizing plotting field correspond to lines ruled on the horizontal plate (Fig. 3,*L*).

the head of the instrument is lowered out of the way of the drill, and the surgeon uses the pointer pencil as a guide. If the drill is kept parallel to the pencil, it will penetrate to the femoral head along the central axis of the neck. Any advisable deviation from this course of the drill is easily determined by studying the two roentgenograms and is easily duplicated

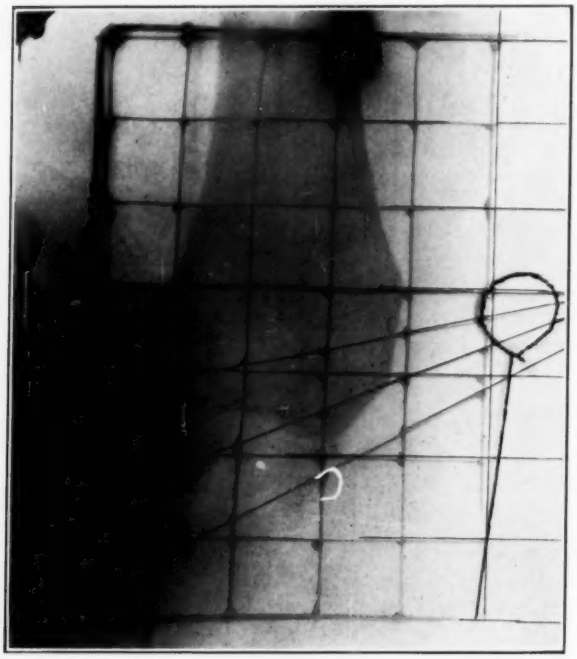

FIG. 5

FIG. 5

Vertical roentgenogram. This view gives the commonly called "anteroposterior" presentation of the femoral head and neck. Post *R* of the pointer instrument (Fig. 3,*M*) must be adjusted by means of its corresponding graduation mark to bring the instrument head to the height of the central axis of the head and neck as indicated by their position on the line shadows of the localizing plotting field.

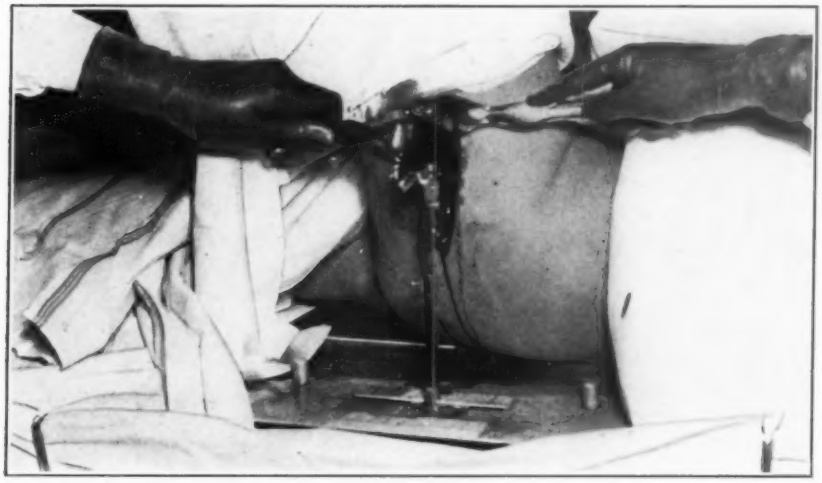

FIG. 6

Incision made and pointer instrument "set" to "spot" insertion point on cortex of trochanter.

in the "set" of the pointer. Figure 6 shows the pointer marking the position of the central axis on the cortex of the trochanter.

The entire operation of this device is much more simple and direct than such a detailed explanation might imply. Much thought has been given toward such simplification of the device as to make it practicable for the use of any surgeon familiar with major bone surgery.

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CARPOMETACARPAL DISLOCATIONS

Report of a Case

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This rare injury is of twofold interest: First, there occurs an injury which seemingly is impossible from an anatomical standpoint; second, very good function is usually obtained with or without reduction.

CASE REPORT

J. P., negro, male, aged thirty-five, came to the Emergency Room of the State University Hospital on March 11, 1936, complaining of an injured right hand. The patient was intoxicated and had fallen down a stairway. He had no idea of how the hand was injured during the fall.

Examination was negative except for the injured hand, which was severely swollen. There were no marks or bruises. The hand was thickened anteroposteriorly and shortened. The proximal ends of the metacarpals could be palpated as a hard, transverse ridge across the dorsum of the wrist. Finger, thumb, and wrist motions were unimpaired except for a moderate amount of pain.

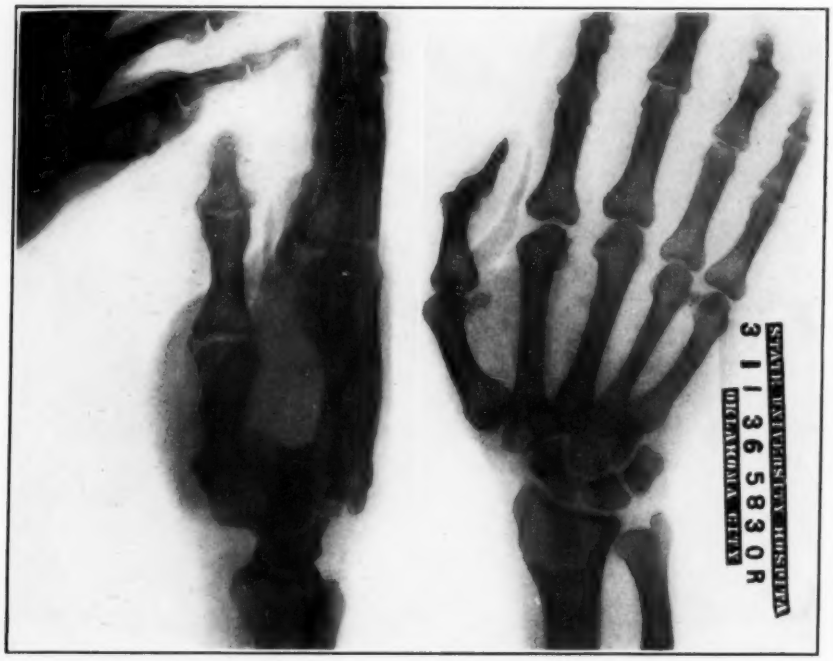

FIG. 1-A FIG. 1-B

Carpometacarpal dislocation before reduction.

* Service of Earl D. McBride, M.D.

Roentgenographic examination revealed a posterior dislocation of the second, third, fourth, and fifth metacarpals on the carpals. No fractures were observed. (See Figures 1-A and 1-B.)

The patient refused a general anaesthetic. Local infiltration into the dislocated joints with 2-per-cent. procaine produced excellent anaesthesia. Reduction was accomplished by traction and by levering the metacarpals, first with slight flexion to unlock the bases, then pressure over the bases when sufficient extension was obtained. The dislocations of the fourth and fifth metacarpals were reduced first, after which the second and third metacarpals slipped easily into place. There was no tendency toward redislocation. A split plaster cast was applied. (See Figures 2-A and 2-B.)

Later, skin traction was applied to the fingers and a sponge was placed over the dorsum of the metacarpals, as it was feared there might be posterior slipping. All support was removed after twenty-two days. Wrist and finger function was painless and normal. No further trouble has been reported.

REVIEW OF LITERATURE

There is relatively little in the literature regarding this injury. Stimson, in 1905, stated definitely that only four cases of dislocation of the four ulnar metacarpals had been reported. Two of these were volar dislocations and two were dorsal. Most of the cases had been diagnosed post mortem. There was no information as to the usefulness of the hands.

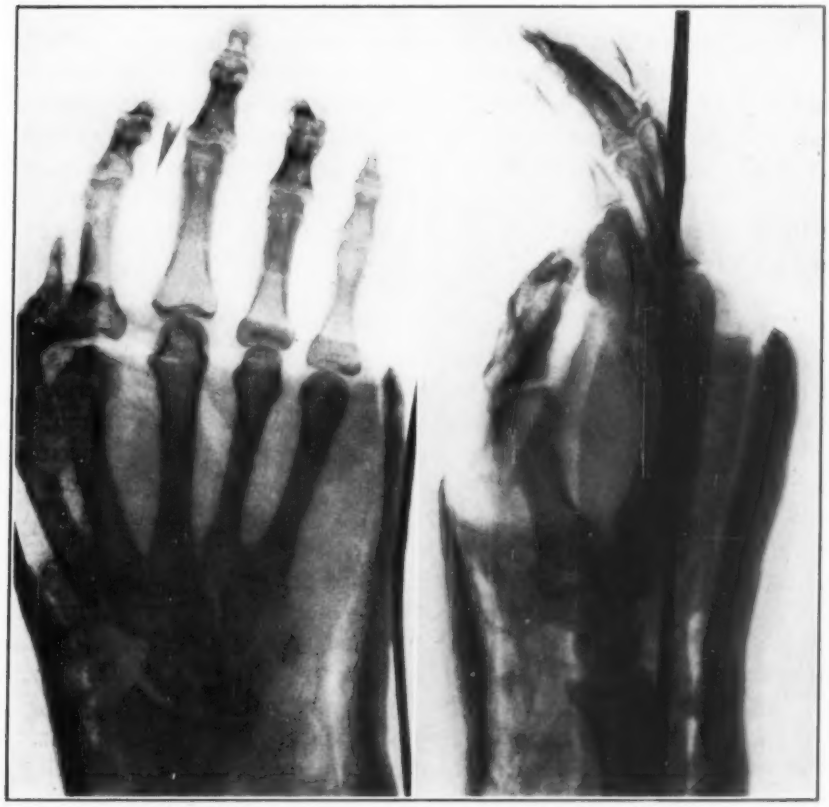

FIG. 2-A FIG. 2-B

After reduction.

Hammann described a case of dorsal dislocation of the fifth carpometacarpal joint. He stated that the injury was very rare, but he did not review other cases. His discussion was primarily concerned with the mechanism of production of the injury.

Burmeister reported a case of dorsal dislocation of the second to fifth metacarpals. His patient received a strong blow on the dorsum of the hand in a car accident. He suffered little pain and refused reduction, due to lack of discomfort or dysfunction. He was seen two years later and functionally had a useful, but deformed hand.

Key and Conwell discussed briefly this injury and showed an excellent roentgenogram of the dislocation. In their opinion a backward dislocation is the most common of the dislocations. Functional results were not discussed.

Schnek reported only two posterior carpometacarpal dislocations in 437 cases of carpal injuries.

ANATOMICAL CONSIDERATION

The carpometacarpal joints, with the exception of the first, are of the arthrodial-diarthrosis type. The second to fifth metacarpal bases articulate with the distal row of bones of the carpus by a series of elevations and depressions which fit together rather snugly. The joints are bound closely by a capsule, weakest on its radial side and composed of short fibrous slips extending longitudinally on the dorsal and volar surfaces. Two interosseus ligaments are usually present, reaching from the bases of the third and fourth metacarpals to the adjacent margins of the hamate and the capitate. The common capsule encloses the entire series of joints, both between the bases of the metacarpals and between the carpometacarpal joints.

METHOD OF PRODUCTION OF DORSAL CARPOMETACARPAL DISLOCATIONS

Burk attempted to produce this dislocation on cadavera. Usually he obtained fractures. It was necessary for him to cut the anterior and posterior ligaments to obtain a dislocation. The author has repeated Burk's experiments with similar results. Attempts on fresh specimens with the carpus fixed were unsuccessful unless the anterior and posterior ligaments were divided. The dislocation could then be effected by unlocking the bones with flexion and pressure posteriorly on the bases of the metacarpals.

No one type of injury produces this dislocation. Direct blows may result in a posterior dislocation, as Burk has described. Bullets or automobile accidents have been known to cause it. There is almost invariably soft-tissue damage with a direct injury.

Indirect injuries unquestionably have been responsible for many of these dislocations, but the exact mechanism is vague. It is interesting to speculate on mechanical forces applied to the wrist, but any conceivable type of blow, twist, or bend might result in one of several injuries. Other

factors enter,—namely, the state of muscle contraction at the precise moment of the injury; weakness, either occupational, acquired, or congenital; and exact conformation of the bones at these joints. With the entire carpus fixed, sudden flexion or extension of the metacarpals could result in a dislocation. The dislocation may be either anterior or posterior depending upon the direction of the force.

SUMMARY AND CONCLUSION

Posterior dislocation of the carpometacarpal joints is a very rare injury. Due to the normal relative immobility of these joints and the fact that the tendons are not firmly bound in this region, unreduced dislocations do not produce serious disabilities. Better results, cosmetically and functionally, may be obtained by reduction, which is easily accomplished in an early case under local or general anaesthesia. Reduction of old cases should receive serious consideration before attempts are made, since the only improvement would be in the appearance of the hand, and it might be made a much less usable member.

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COMPOUND DISLOCATION OF THE TALUS WITHOUT MALLEOLAR FRACTURE

BY JOHN PAUL NORTH, M.D., PHILADELPHIA, PENNSYLVANIA

It is commonly supposed that the talus cannot be dislodged from the ankle joint by injury unless one of the malleoli or a lip of the tibia is fractured. In the main, this is true and certainly most dislocations at the ankle have associated fractures of the long bones. Lateral dislocation accompanying fractures of the Pott type is familiar to all. Posterior dislocation, which occurs when the posterior lip of the tibia is broken, is also common. Less frequently a fracture of the anterior lip of the tibia may permit anterior luxation of the foot, or upward displacement of the talus may occur if the inferior tibiofibular ligaments are torn, with resultant widening of the mortise. The case reported herewith is an example of internal dislocation of the foot without associated fracture, and there are on record sufficient cases of similar character to warrant the recognition of the possibility of its occurrence. Prior to the x-ray era such cases were described, but, lacking roentgenographic confirmation, the diagnosis is open to question. In a review of 108 cases collected by Wendel, at least one dislocation appears to have been unaccompanied by fracture. Stimson quotes Malgaigne to the effect that eight such cases were recorded prior to 1900.

The earliest authenticated case of uncomplicated dislocation seems to be that of Sievers. In this case, the tibia and fibula were intact, although there was a chip fracture of the posterior lip of the superior articulating surface of the talus. Subsequently, isolated cases have been recorded by Péraire, Gillen, Green, Pedlow, Hirschfield, Dehne, Pegreffi, Aboulker and Herbert, Conwell and Alldredge, and Sloane and Coutts. In each instance the foot was rotated inward, so that the superior surface of the talus presented below the fibular malleolus. In addition, Scharsich reported two cases of simple dislocation, thus making thirteen in all. The usual mechanism described in the production of these injuries is a fall or other accident of such nature that the weight of the body is thrust suddenly upon the outer aspect of the inverted foot. Six of the ten dislocations were compound. In one instance the navicular and in another the talus was completely extruded. These tarsal bones were replaced and, although the result is not recorded in the case of extrusion of the talus, the patient with extrusion of the navicular was able to walk normally in two months. Of the total number of cases, good functional results were reported in five cases, while in the remainder the results were not stated. One of Scharsich's patients had a fracture of the head of the fifth metatarsal similar to that in the following case.

CASE REPORT

Miss H. C., aged forty-two years, fell down a flight of stairs in her home and landed with one foot turned inward. Her family physician saw her within a few minutes, applied tincture of iodine and a sterile dressing to the wound, and sent her to the hospital. She had a compound dislocation of the tibio-astragalar joint, the astragalus being rotated through 90 degrees, so that its superior aspect presented in an open wound on the lateral aspect of the ankle. The malleoli were intact and the only fracture shown in the roentgenogram was one of the base of the fifth metatarsal at the point of insertion of the peroneus longus tendon. There was a narrow bridge of skin tightly stretched between two parallel wounds.

Operation was performed ten hours after the injury. First the surrounding skin and then the wound itself were painstakingly cleansed with abundant quantities of soap solution and water. All contused soft tissues were excised. The dislocation was then reduced and the ruptured ligaments were sutured. Very little tissue was available for the closure, and the joint cavity could only be sealed by using a flap of skin raised from the outer aspect of the leg and slid downward over the ankle. The original wound was thus closed without drainage, and the site of the sliding graft was later covered with pinch grafts. Healing took place without infection.

Partial weight-bearing with crutches was permitted four weeks after the accident. There was recovery of full range of motion at the ankle and in the foot, and, during the four years which have elapsed since the injury, the patient has been walking without pain and has had no sprains of the ankle.

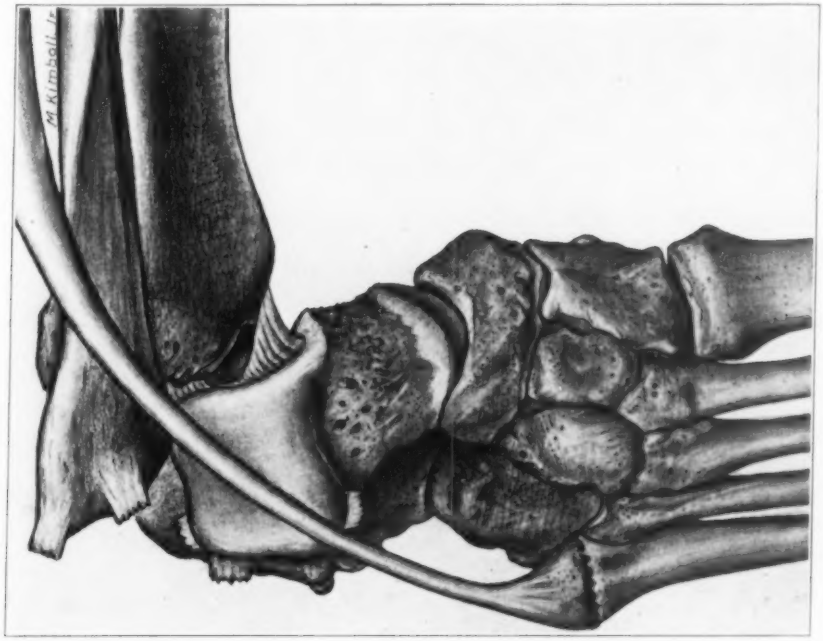

FIG. 1

Drawing showing position of dislocated foot and sprain-fracture of the base of the fifth metatarsal. The displacement of the peroneus longus tendon outside the fibular malleolus is schematic.

The treatment of such a case by débridement and suture without drainage makes for a good recovery provided of course that infection does not supervene. Primary closure was possible in this case because of the

conditions under which the accident occurred, the prompt and efficient first-aid treatment, and the early stage at which operation was done. Many compound dislocations must of necessity be treated by other methods, because of actual or threatened contamination.

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HIP FRACTURES

Valgus Position—Accidental or Engineered

BY FREDERIC JAY COTTON, M.D., AND GORDON MACKAY MORRISON, M.D.
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It is a well-recognized fact that, whatever treatment is resorted to, vastly better results are obtained in intracapsular fractures of the neck of the femur if the displacement happens to be into the "valgus" position. (See Figure 1.)

What is new is that we have lately learned how to produce this valgus position at will, and consistently.

There is no question that with a valgus position one gets a more favorable line of muscle pull, less damaging strain from weight-bearing in the sense of cross strain, and the tendency is toward lengthening rather than shortening of the leg. We knew this long ago, and many of us have tried for a consistent technique by which we could shove the fragments into the valgus position. We failed uniformly.

And some of us did vast and futile experimentation on the cadaver and on the living, to contrive a "valgus" reduction, but with no consistent results!

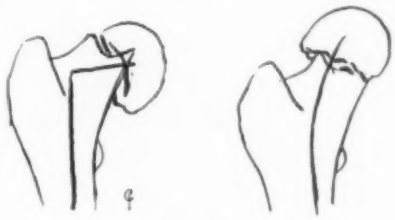

Fig. 1

Left: The usual "varus" position of so-called "impaction".

Right: The "valgus" position. Note the difference measured in cross-breaking strain.

Only lately, when we finally obtained "lateral" roentgenograms of adequate quality, did we realize the previously overlooked factor of forward *rotation* of the proximal end of the distal (neck) fragment.

Only with this vision was it possible to work out accurate reduction.

Prior to 1933, Leadbetter and one of the writers devised manipulation independently, curiously similar in detail, for *accurate reduction*.

The writer then expressed a hope that such accurate reduction might in itself solve the problem of absorption of the neck.

But it failed to do so. Absorption of the *proximal* fragment (independent, it seems, of the arterial nutrition of the *head*) goes on in 1938 just as in 1933.

We have moved ahead slowly and can say for the first time that a hip fracture *accurately* reduced by methods quoted can be further reduced into a valgus position with a vast advantage, and this can be done with precision.

The fact is that a hip fracture, once *accurately reduced*, can be converted into a *valgus* position rather exactly with very significant benefit as measured by end results.

The artificial impaction of hip fractures—even of hip fractures not

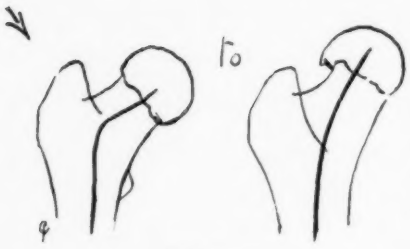

FIG. 2

Left: Approximate anatomical reduction.
Right: Impaction into "valgus". Direction of impaction *in and downward.* Note the weight-bearing line and the difference in "cross-breaking" strain.

always well reduced—dates back many years. The senior writer, followed by Smith-Petersen and many others, has done many impactions, with results which yielded at least personal satisfaction and probably great benefit.

However, these have been impactions *in the line of the neck.*

Now we have learned, but only lately, that we can impact a *neutral* reduction *into the position of "valgus"* to a position that we know to be far more favorable to recovery and union, and, like so many things of importance, it is ridiculously simple.

The procedure is to reduce the hip accurately by the method now in use,—namely, traction in the line of the femur, hip and knee being moderately flexed; sharp adduction; knee crossed over the thigh of the sound side; sharp inward rotation of the broken limb, followed by bringing the leg down into slight abduction (20 degrees more or less) without letting up on the inward rotation. (See Figure 2.) The result is checked both by anteroposterior and lateral roentgenograms. It may be necessary to repeat this manoeuver.

This method of reduction requires some force, and there is little chance of overreducing. In only one out of many cases have we been obliged to repeat the procedure because we had overreduced the displacement. The usual fault is in not using enough force.

FIG. 4

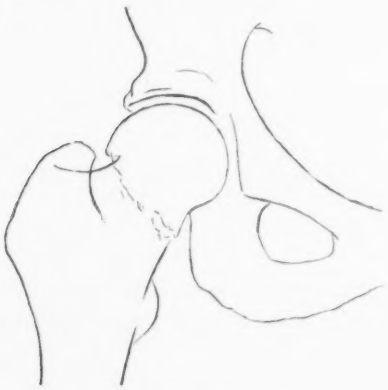

FIG. 3

Figs. 3, 4, and 5: Typical cases of accidental valgus displacement with subsequent bony union.

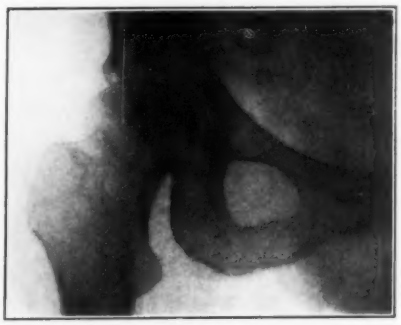

FIG. 5

FIG. 6

FIG. 7

FIG. 8

Figs. 6, 7, and 8: Other typical cases of accidental valgus displacement with subsequent bony union.

When satisfactory position is attained, comes the time for converting the neutral (normal) position *into valgus by impaction.*

The leg is abducted 20 or 30 degrees from the mid-line of the body. In obese patients one cannot abduct much and still reach the trochanter to impact. We use a heavy wooden mallet to impact with, the limb being protected by a single layer of heavy felt. A tightly stuffed cylindrical sandbag of four-inch thickness can be used and with this no felt is needed for protection. We have done many impactions in this way, but we feel that the hammer gives more exact control and, with this newer impaction, exactness is essential.

With the hammer, the trochanter is struck and driven home. The blow is a slow swing of the heavy mallet.

The direction of the blow is not in the line of the neck, as with the old impaction procedure, but across it at an angle of roughly 45 degrees with the mid-line of the body.

Since the limb is already abducted, this gives a total angle of from 70 to 75 degrees or, perhaps better stated, an angle of from 105 to 110 degrees with the shaft.

The force, then, is applied in a line to push the neck fragment across under the head at the same time that the neck is impacted into the head. This can be done quite exactly with a little practice. We have never failed as yet to get the desired position.

A word of caution is necessary: It is very important that the blow be struck parallel to the table. There is a possibility of shoving the neck fragment to front or back.

FIG. 9-A

Fracture of hip with loose fragments.

Following reduction and impaction, we have nailed the fragments with Krupp nails from three to three and one-quarter inches long according to the individual case. The incision is small; drilling is done under fluoroscopic control; and the nails are inserted in the drill holes and tapped home, using a nail set.

Then, gently, the final impaction is done with the impactor devised by Smith-Petersen, which straddles the nail and rests on bone.

Suturing and dressing follow.

In only one case (when patient was convalescent) have we used a Thomas splint and in no case have we employed a plaster spica.

FIG. 9-B

After reduction. Fragments in valgus.

FIG. 9-C

Fragments nailed.

FIG. 10-A

First case deliberately treated by the technique described, before reduction.

FIG. 10-B

After nailing. The patient at present has serviceable bony union.

It may be well to add a brief account of the reasoning that led to the devising of this new method.

In recent years we have had occasion to treat not a few broken hips. Those that have interested us particularly are these "valgus" hips, perhaps eight in all.

These are cases, often in relatively young people, of intracapsular

FIG. 11-A

Fracture of the hip with loose fragments.

FIG. 11-B

After reduction, impaction, and nailing. Patient at present convalescent. Apparently a very favorable case.

fracture with little upward displacement and with little or no *rotary* displacement. The displacement, such as it is, is of the *distal* fragment *inward.*

The significant factor in the history—from those with any useful memory of the accident—is uniformly that of a crash *sideways onto* the trochanter.

This is an entirely different story from that of the elderly patient whose leg gives way in mid-air or who sits down half sideways in a sitting "squash" fall.

This seems most significant if we accept the stories. We *do.* In these patients the distal part of the hip is driven *inward:*

without rotation
without great displacement
without great damage to capsule
without damage to ligamentum teres
without damage to pericapsular vessels.

And, therefore, they do well from the start, and the course of repair is continued without the handicap of any cross strain from muscle pull or weight-bearing.

It is scarcely to be hoped that in cases of different initial mechanism, of greater soft-part damage, that a reproduction of the valgus position can bring the worst cases quite into the better class, but we believe it to be a very important factor.

No claim is made that such reduction with impaction has any effect in avoiding or reducing the "death of the head" * or the aseptic necrosis and absorption of the near end of the distal fragment, due, one supposes, to damage of the blood supply, mainly arterial. Over these calamities we have no control as yet.

But, if the neck (spiked or unspiked) is going to absorb, then the val-

FIG. 12-A

Fracture of the hip with loose fragments.

* Real, but a bit overplayed perhaps—not usual or common.

FIG. 12-B
After reduction.

FIG. 12-C
After impaction.

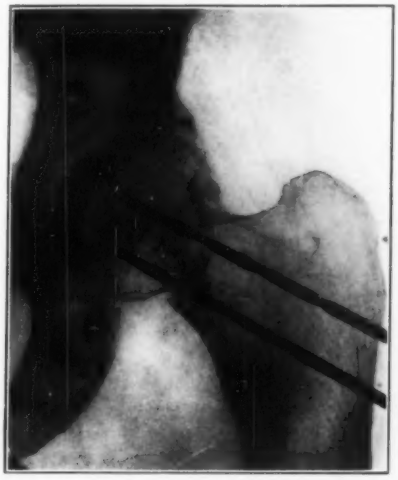

FIG. 12-D
After drilling under fluoroscope.

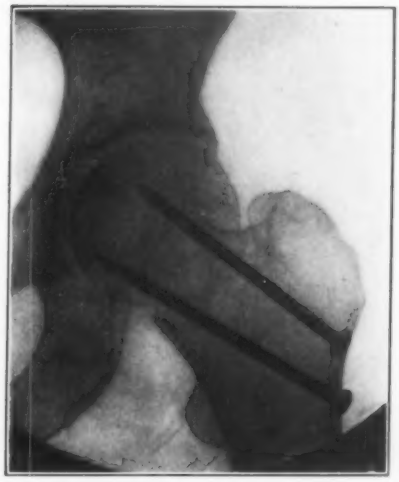

FIG. 12-E
After nailing.

gus position is the posture in which the bone may best resist this misfortune.

A very considerable number of such cases (the neck absorbed) go on (protected) within a year to bony or, at worst, *serviceable close fibrous* union, whatever the exact detail of treatment. But these are usually "valgus" cases.

We believe this matter of *controlled* determination of position to be very important.

It is too soon to talk of results. Probably they will not be consistently good, but we believe they will be better.

After all, this whole problem of intracapsular hip fracture is only for the optimist.

Some of those who have worked on it for thirty years have the bitter taste of failure and a bit of skepticism about reported 100-per-cent. results.

But, results *can be bettered, are being bettered*, and this matter of controlled reduction into valgus may well prove an important factor.

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A BONE PLATE WHICH WILL NOT BREAK OR BEND

BY GEORGE W. HAWLEY, M.D., WESTPORT, CONNECTICUT, AND
RALPH D. PADULA, M.D., NORWALK, CONNECTICUT

The occasional accident of bent or broken plates, in the hands of experts in the large medical centers, caused the Fracture Committee of the American College of Surgeons to appoint, a few years ago, a special committee to find ways and means to reduce this hazard. For the past ten years the senior writer has been working on a bone plate which will not bend or break and yet is technically easy of application and removal, should removal at any time be desired. At the same time, the effort has also been made to obtain unusually strong fixation of the plate to the bone.

The plate shown in Figures 1, 2, and 3 appears to meet these requirements. It has been tested for tensile strength on human dried bones and cadavera. It has been used in two cases of fracture of the shaft of the humerus, in two cases of fracture of the tibia, and in one case of fracture of the femur. As there is no essential difference between this plate and the Sherman plate from a clinical point of view, the case reports are omitted. In each case early callus has been observed in the roentgenograms, and no loosening of the screws has been noted. We have no idea what future experience may prove,—whether the screws eventually will become loose, and, if so, how early. As yet we have not removed a plate.

There is little technical difference in the application of this plate and the Sherman plate. The junior writer, who has carried out the experimental operative work on cadavera and dogs, has found a method of application which makes the operation somewhat easier and quicker than applying a Sherman plate.

The plate is an angle iron made of stainless steel, and is fairly thin, light, and compact. There is one size of plate for the femur and the tibia (weight-bearing bones), one for the tibia and the humerus, one for the humerus, and one for the radius and the ulna. Long screws are used so that they pass completely through the bone and extend about one-fourth of an inch. This is to ensure good threading and to hold in the distal cortex. The plate is applied from the side of the bone, so that the screw ends are visible. The ends of the screws are cut off flush with the bone by means of a jeweler's wire saw. With this small instrument, a notch is cut on the side of the screw which breaks off by bending. The burred screw end makes it more difficult for the screw to pull out, but does not hinder removal.

Two drill points are used. One is for the cortex distal to the plate and has been carefully selected, so that it is neither too small nor too large. If the drill point is too small, it is difficult to insert the screw without breaking its head. If the point is too large, the screw does not get a secure hold on the bone. Screws act to thread the hard bone and must obtain a firm hold. The other and larger drill is for the cortex proximal to the plate. This drill makes a hole slightly larger than the screw.

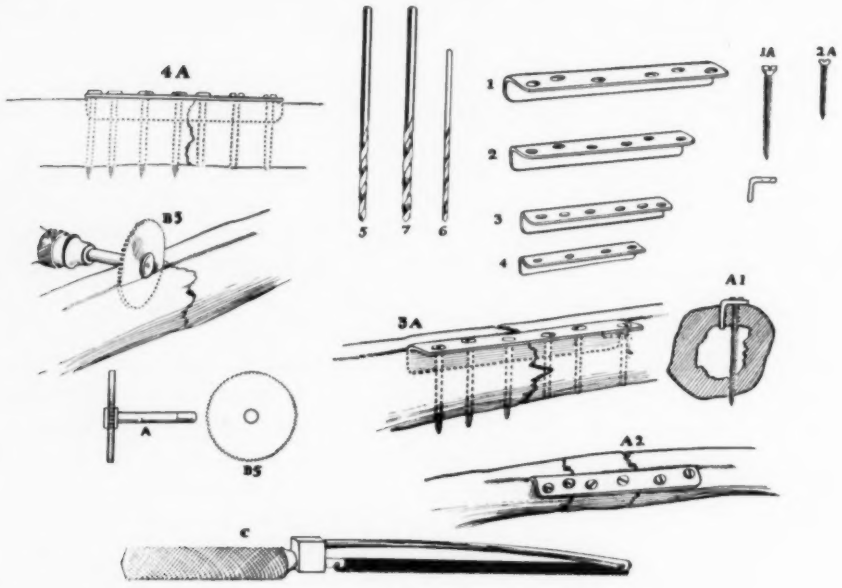

FIG. 1

Showing sizes of plates:

1: Plate for femur and tibia, four inches long, with flanges three-eighths of an inch wide and one-sixteenth of an inch thick.
2: Plate for tibia and humerus.
3: Plate for humerus.
4: Plate for radius and ulna, two inches long, one-quarter of an inch wide, and three-sixty-fourths of an inch thick.
5, *6*, and *7:* Drills used: gage 34, 35, and 28.
1A: Screws for large plates: one and one-quarter inches, one and one-half inches, and one and three-quarter inches by one-eighth of an inch in diameter.
2A: Screws for small plate: one-half an inch and five-eighths of an inch by five-sixty-fourths of an inch.
A: Circular saw, one-sixteenth of an inch wide.
B5: One way of cutting slot for plate, given up for method described in text.
C: Jeweler's saw for cutting notch in ends of screws, so that the ends break off easily.
A1: Cross-section of plate and bone.
A2: Lateral view of plate attached to bone.
3A and *4A:* Diagrammatic views of plate, showing some screws cut off.

Our experiments show that six screws are advisable for the weight-bearing bones (the tibia and the femur). For the non-weight-bearing bones, we believe that four screws—two in each fragment—are sufficient.

The junior writer has arrived at the following technique after experimenting on cadavera and dogs and after operations on patients:

An incision is made to expose the bone on its outer surface. Exposure is free and adequate. In fractures of the tibia and the femur, the leg is put in traction on a fracture table to stabilize the limb and to reduce partly overriding and deformity. The bone ends are fully freed from the soft parts. No attempt is made to approximate the ends at this point, except to align and to mark each fragment with a sharp instrument for the longitudinal saw cut. One bone end is then lifted out of the wound, and a slot is cut with a motor saw. The blade of the saw is of the same thick-

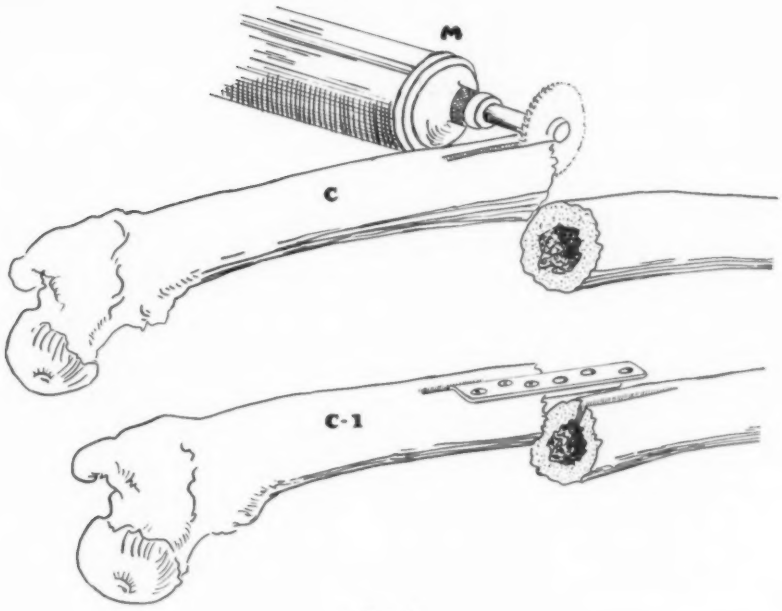

FIG. 2

M: Albee saw with saw blade one-sixteenth of an inch thick.
C: Bone end elevated for cutting slot.
C-1: Plate fastened to one bone end ready to fit into cut in opposite bone end.

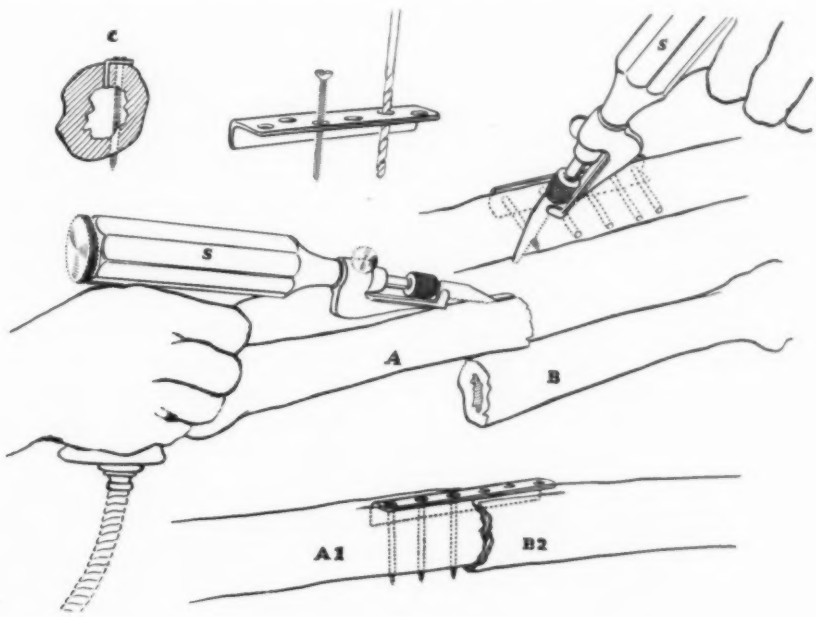

FIG. 3

S: Cayo saw cutting slot in one bone end and cutting off ends of screws with hack-saw blade.
A-1 and *B-2:* Fitting plate into slot to complete reduction.

ness as the plate. While the bone end is raised, one-half of the plate is inserted into the slot and the bone is drilled,—first, the distal cortex with the smaller drill; then, the proximal cortex with the larger drill. The screws are then inserted and the ends are cut off.

The other bone end is raised out of the wound, and a saw cut is made in the line already marked. The fragments are then approximated, and the plate is slipped into the bed which has been prepared for it. The ends are then impacted one against the other by pressure in the long axis of the bone. The final screws are inserted and the ends are cut off. The wound is closed, and dressings and a cast are applied.

We wish it to be understood that we do not advocate the operative treatment of fractures, except in certain cases in which operation seems justified. On the contrary, we believe that plating operations should be left to those with adequate training and instrumental equipment. We simply offer this plate as a substitute for the Sherman plate, solely by reason of the fact that it will not break or bend.

Since the above was written, we have been using plates made of vitallium, an alloy which does not contain iron and which resists corrosion.

The scientific and painstaking experiments carried out by Dr. C. S. Venable on the electrolysis induced by different metals buried in living tissue show that vitallium is devoid of electrolytic action, and so-called "eighteen and eight" stainless steel (18 per cent. chromium and 8 per cent. nickel) has very little. Both are highly resistant to corrosion. At the present time we are inclined to believe that there is little choice between the two, but in this we may be mistaken.

The plate which we have described was informally presented at the Annual Meeting of the Fracture Committee of the American College of Surgeons in New York, on February 18, 1938. The question of cutting the slot was raised. In our experimental operations we expected to encounter some difficulty, but in practice the cutting of the slot and the fitting of the plate proved quite easy. One difficulty is, however, quite obvious. This is the use of penetrating screws which have to be cut off. Our experiments indicate that this provides the strongest anchorage of the plate. It may be that this is not necessary, that screws which just penetrate the full diameter of the bone are sufficient. It is not difficult to select such screws by measuring the diameter of the bone at operation. Such screws are advised when a plate is applied on the anterior surface of a bone and not from the side, so that the screws are visible. A plate may be applied with screws which only penetrate the cortex next to the plate, but the hold of the plate depends on the screws, and our tests show that, under strain, such screws will pull loose.

Weakness in the screw, near the head, is the only structural defect which we have encountered. Not often, but occasionally, the head of a screw has broken off at operation. With more careful introduction this would probably not occur.

TYPHOID SPINE

BY H. A. SWART, M.D., F.A.C.S., CHARLESTON, WEST VIRGINIA

Typhoid involvement of the spine has never been common; according to Gall, the incidence is one case in every 1800 cases of typhoid fever. In recent years, due to better milk and water supplies, it has become quite rare. The following case is interesting in that the patient was under observation from the time of onset of the typhoid fever, through the period of active involvement of the spine, until apparent cure was effected.

CASE REPORT

A. P., white male, aged nineteen, unmarried, was admitted to the Charleston General Hospital on February 22, 1936, with the history of having suffered from chills, fever, delirium, and diarrhoea for two weeks. On admission his temperature was 104.4 degrees, and the pulse rate was 120. Physical examination revealed the presence of herpes, congestion of the pharynx, and a markedly distended abdomen. The blood count showed 4,100,000 erythrocytes, and 10,100 leukocytes, with hemoglobin of 91 per cent. The Widal blood test was reported positive by bacillus typhosus in a dilution of 1:500. The disease ran a stormy course with marked delirium and fever up to 105 degrees for two weeks. He was given intravenous fluids and blood transfusions, following which his temperature subsided. He was allowed to go home on March 22, 1936, after having been in the hospital one month.

The patient returned to the hospital on April 23, 1936, with the complaint of low-back pain, accompanied by fever, which he had had for one week. His local physician had found pus in the urine. On the day of admission he had had a chill. Examination at this time revealed tenderness and muscle rigidity of the right lumbar region. His temperature was 103.6 degrees. Analysis of the urine showed a definite amount of pus,—2 plus on a basis of 4. Reexamination of the blood disclosed nothing significant. A test for undulant fever was negative. Roentgenographic examinations of the chest and abdomen were negative, except for the finding of scoliosis of the lumbar spine to the left. A retrograde pyelogram was made on May 4, 1936, and nothing was shown except the scoliosis to the left as before. A roentgenogram on May 20, 1936, showed only scoliosis of the lumbar spine. A diagnosis of pyelitis was made and the patient was put on a ketogenic diet. His temperature fluctuated in an irregular manner, but gradually came down to normal at the end of three weeks. The pain gradually became less and at the end of sixty days, on June 26, he was again dismissed from the hospital.

The patient was readmitted to the hospital on August 1, 1936, at which time he was first seen by the author. He complained of a severe aching in the right lumbar region. He also stated that the right leg was shorter than the left, and that the left leg was weak, forcing him to use crutches to get about. Examination revealed a total curve to the left in the lumbar area. There was no particular tenderness of the spine or adjacent muscles. Motions of the spine produced pain in the right hip. There was marked weakness of the muscles of the left leg with absence of the knee jerk on that side. The ankle jerk, however, was present. In the right leg all reflexes were active. There was atrophy of the left thigh, amounting to two centimeters, but none in the calf. The spinal fluid was examined and found to be negative. Urinalysis was negative and blood studies were again not significant.

A roentgenogram of the lumbar spine (Figs. 1-A and 1-B) revealed a destructive process between the second and third lumbar vertebrae with involvement of the disc and scoliosis to the left as before. The temperature at this time was normal. A diagnosis of

typhoid spine was made, and the patient was placed on a hyperextension frame with ten pounds of traction by Buck's extension on each leg. This was left on thirty days, and some improvement of the scoliosis was noted. A hyperextension cast was then applied from the upper chest to the knee on the right, and twelve days later the patient was allowed to go home wearing the cast.

He remained comfortable in the cast, and at the end of three months it was removed. At this time the patient stood tilted slightly to the right, and a roentgenogram showed almost entire disappearance of the disc between the second and third lumbar vertebrae. A Taylor brace was obtained for him, which he wore regularly for four months. Then he was allowed to leave it off one hour per day and this was gradually increased until the brace was discarded.

On June 1, 1937, ten months after the diagnosis was made, motions of the spine were found to be good and painless. There was a slight curve to the left in the lumbar region, but his back gave him no trouble.

On July 19, 1937, the patient came to the hospital for permission to go to work. The mild scoliotic curve to the left was still present, but all motions were completely painless. A roentgenogram at this time (Figs. 2-A and 2-B) showed loss of the disc between the second and third lumbar vertebrae with evidence of healing of the lesion and scoliosis with convexity to the left.

On August 5, 1937, the patient was again seen. He stated that he had worked eight days and had then stopped because he did not like his work, not because of pain in his back. Examination at this time revealed what seemed to be a normal spine with the exception of the slight curve. The left knee jerk had reappeared, and the circumference of the thighs was the same.

FIG. 1-A

FIG. 1-B

Lateral and anteroposterior roentgenograms of the lumbar spine, showing a destructive process between the second and third lumbar vertebrae with involvement of the disc and left scoliosis.

Mercer and Jones and Lovett state that such a condition is osteomyelitic in character, but in the present case the process appeared to be an osteitis rather than an osteomyelitis, as there was at no time any evidence of abscess formation.

This case shows that, in addition to involvement of the vertebrae in typhoid spine, the nerve roots may also be affected. Mercer states that frequently tenderness along the sciatic nerve, hyperaesthesia of the lumbosacral region, and sometimes anaesthesia of certain parts of the hip and the leg are noted. He also points out that the reflexes are usually increased. In this case the knee jerk on the left side was abolished at one time, and there were no sensory changes.

According to Mercer, the roentgenographic changes show broadening of the intervertebral discs with deposits of bone on the lateral aspects of the affected vertebrae. Our roentgenograms, however, showed destruction of the intervertebral discs and the adjacent borders of the vertebral bodies.

Whitman states that the symptoms usually last six months, and that the outlook is good. In our case, we allowed the patient to go without support at the end of eight months, and he was apparently completely well in one year. It is felt that recovery in this case was expe-

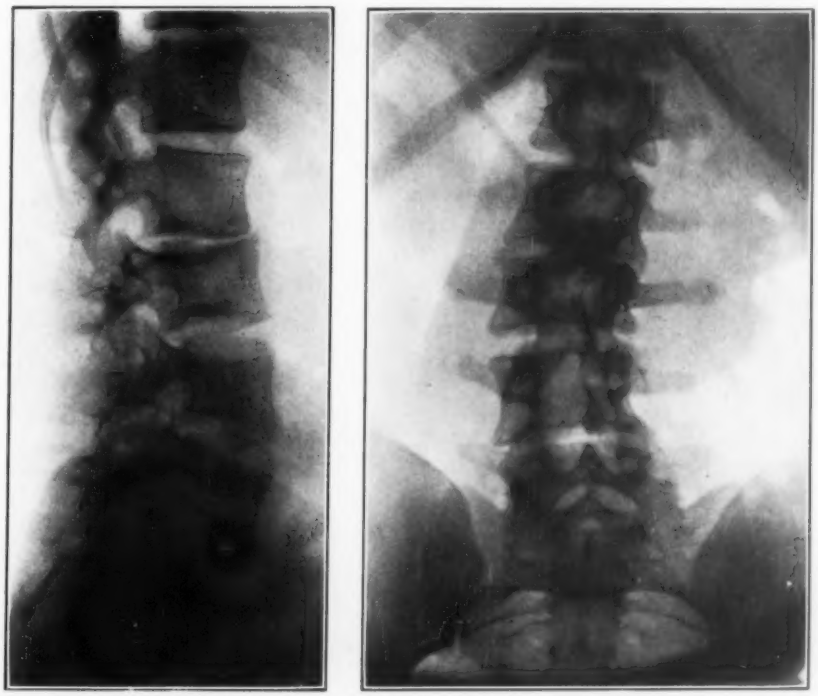

FIG. 2-A FIG. 2-B

Lateral and anteroposterior roentgenograms of the lumbar spine, showing loss of the disc between the second and third lumbar vertebrae with evidence of healing of the lesion.

dited by traction in hyperextension on a convex frame, and by the continuation of the hyperextension by the cast and the brace.

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BILATERAL UNDESCENDED SCAPULA WITH OMOVERTEBRAL BONE

BY PARKER C. CARSON, M.D., SPRINGFIELD, MASSACHUSETTS

From the Shriners' Hospital for Crippled Children, Springfield

Congenital elevation of the scapula with omovertebral bones is an uncommon congenital anomaly. In 1908 Horwitz reviewed the literature and found twenty-seven cases. Shore surgically removed a unilateral omovertebral bone, and Jackson reported a similar case, describing the condition as being costal in origin and attached to the scapula by cartilage. Jackson's contention that the term "congenital elevation of the scapula" is a misnomer appears quite sound, since, as he points out, embryologically the condition represents failure of the bone to descend. Bilateral occurrence of the condition appears to be exceedingly rare, and the following case is presented for this reason.

CASE REPORT

A twelve-year-old girl was admitted to the Shriners' Hospital for treatment of a bilateral deformity of the shoulders, a left club foot, and bilateral hallux valgus; all of these conditions had been present since birth. The past history and family history were not significant.

Physical Examination

The general examination showed a well-nourished adolescent girl in good health. Orthopaedic examination revealed a short, thick neck with no limitation of movements. (See Figure 1.) The right scapula was high with a very prominent acromion process anteriorly. The superior border was at about the level of the fifth cervical vertebra, and the inferior angle was at the level of the fifth rib. The scapula was slightly movable. It measured five and one-half inches from the superior border to the inferior angle and seven inches from the acromion process to the medial angle. No definite omovertebral bone was palpated. The right clavicle was markedly angulated anteriorly in its distal third. The left scapula was immobile and firmly attached at about the seventh cervical vertebra. A definite process was palpated from the medial angle to the spinous process. The superior border was somewhat lower than the right with a less prominent acromion process. The scapula measured five inches from the superior border to the inferior angle. A definite medial angle was not palpated. The inferior angle was at the fourth rib. A definite scoliosis to the right, centering at the tenth thoracic vertebra, with moderate rotation was present. The lumbosacral articulation was rigid. The superior extremities were normal with the exception of limitation of abduction and circumduction at the shoulder joints above the level of the joints. The inferior extremities were normal except for an equinovarus of the left foot with a marked cavus. The left ankle joint was rigid in equinus at 110 degrees. Bilateral hallux valgus was present. Neurological examination was essentially normal.

Preoperative Roentgenographic Examination

An anteroposterior roentgenogram of both shoulders (Fig. 2), including the lower cervical spine, showed long transverse processes of the sixth cervical vertebra with spina bifida of the fifth, sixth, and seventh cervical vertebrae. These processes articulated

with the medial margins of both scapulae; this was most marked on the left, where the articulation closely resembled a sacro-iliac joint.

An oblique roentgenogram of the shoulders and scapula failed to show on the right any articulation between the transverse process of the scapula; on the left, however, there was a definite articulation, slightly wider than a sacro-iliac articulation, but otherwise very similar to it.

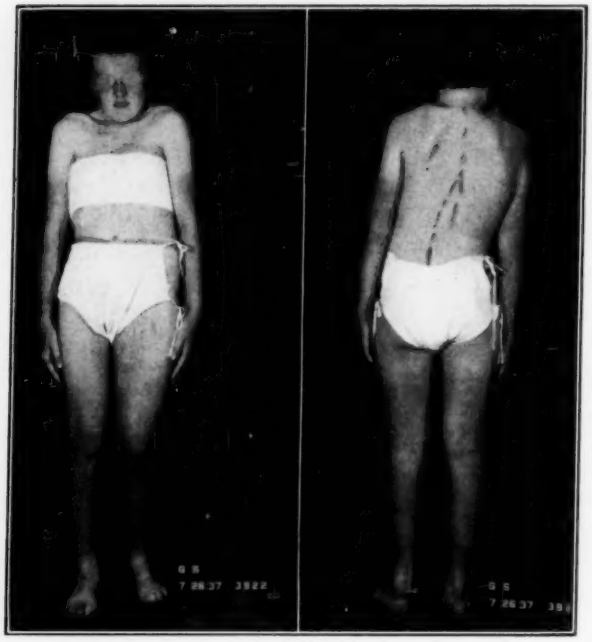

FIG. 1

Patient before operation.

An anteroposterior roentgenogram of the thoracic spine revealed scoliosis of the mid-thoracic spine four centimeters to the right.

An anteroposterior roentgenogram of the lumbar spine and pelvis disclosed sacralization of the transverse process of the fifth lumbar vertebra on the right.

Anteroposterior and lateral roentgenograms showed rather marked hallux valgus of both feet, pes cavus of the left foot, and pes planus of the right foot, but the bones of the right foot appeared normal.

Operation

An operation for resection of the anomalous bony process between the scapula and the sixth cervical vertebra was done. A transverse incision was made beginning at the spine of the left scapula; this was carried to the spinous process of the seventh cervical vertebra and over and across to the spine of the right scapula. The base of the spine of the scapula and the adjacent body of the bone were exposed by subperiosteal dissection, disclosing immediately the anomalous process; this was attached to the medial angle throughout its length by a cartilaginous plate which showed no evidence of joint formation. The process measured approximately two and one-half inches at its attachment to the scapula; it tapered down to about three-fourths of an inch in size and was attached to, or a part of, the transverse process of the sixth cervical vertebra. The scapular end of the bone was freed by cutting through the cartilaginous layer; then subperiosteal dissection was carried down to the vertebral origin of this process, where it was removed near the vertebra with a Gigli saw. Small remaining fragments were trimmed with bone cutters. When the bone was removed, the scapula showed relatively normal mobility. The dissection was then shifted to the right side where a similar procedure was carried out. The anomalous process on this side, approximately three inches in length, showed a pseudarthrosis with the scapula, the tip having a cartilaginous plate without a definite joint formation. The process on this side more nearly resembled a rib and, at its vertebral end, there was a constriction similar to the neck of the rib and an irregular faceted articular end. The direct attachment of this end to the vertebra was not examined, since the direct exposure would require a considerable amount of dissecting which appeared to be unnecessary. The bone was removed subperiosteally. The scapula on this side, however, did not show the marked increased

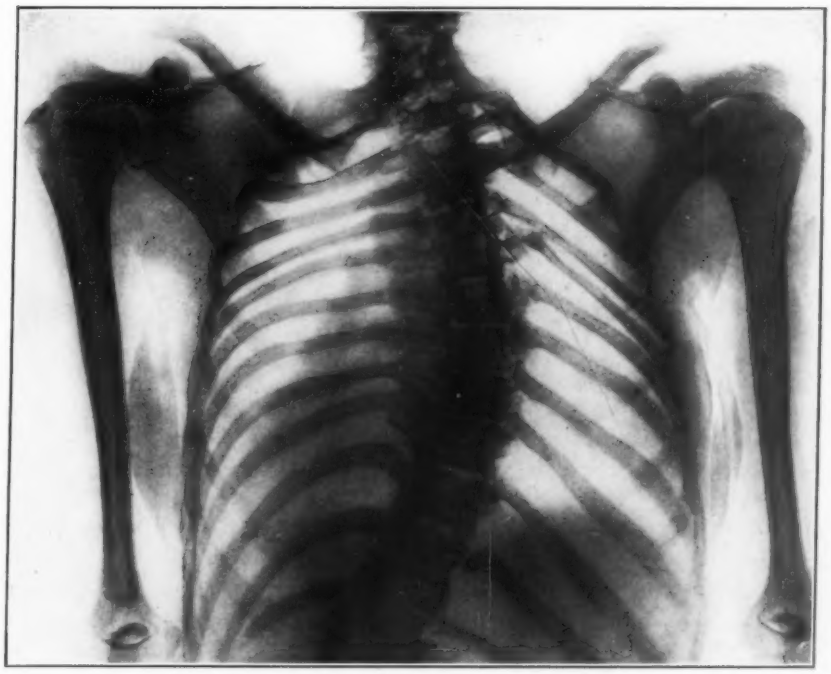

FIG. 2

Preoperative roentgenogram, showing long transverse processes of the sixth cervical vertebra with spina bifida of the fifth, sixth, and seventh cervical vertebrae. The processes articulate with the medial margins of both scapulae.

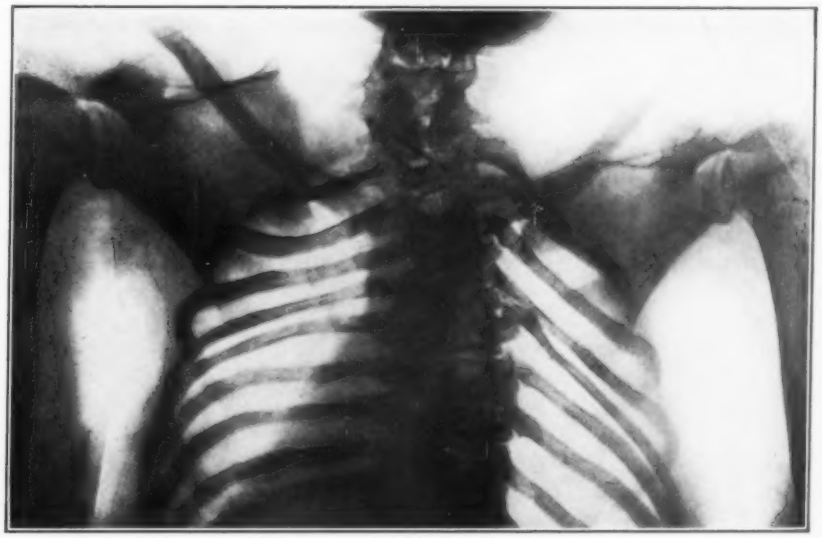

FIG. 3

Postoperative roentgenogram, showing complete removal of the bone which articulated with the scapulae and a slight scoliosis of the cervical spine to the left.

mobility that was found on the left, and posterior displacement of the scapulae was probably inhibited by the clavicles.

Postoperative Roentgenographic Examination

A postoperative roentgenogram of both shoulders and cervical spine (Fig. 3) revealed complete removal of the bone which articulated with the scapulae. The cervical spine showed a slight scoliosis to the left.

End Result

The postoperative course was uneventful. Both scapulae are freely movable. The left is well displaced backward with the inferior angle at the fifth rib. The position of the right is unchanged. Functionally, the patient can raise both arms well above the level of the shoulder joints, with better results on the left.

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PREGNANCY COMPLICATED BY OSTEOPETROSIS

Report of a Case

BY HARLEY E. ANDERSON, M.D., OMAHA, NEBRASKA

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Osteopetrosis, a fairly rare condition, sometimes called osteosclerosis fragilis or marble bones, was first described by Albers-Schönberg in 1904. By the end of 1936 some eighty-three cases had been reported.

As the name "marble bones" implies, the bones of the entire skeleton become very hard, with replacement of the spongiosa by compact tissue, and with extraordinary increase in the calcium content. The most common symptoms are spontaneous fracture and anaemia; the next common are hydrocephalus and blindness.

A review of the cases of osteopetrosis shows the greatest percentage occurring in children, some *in utero;* also a larger number of females than males. The consensus of opinion is that this disease is a hereditary, familial, and constitutional one; the etiology is unknown, although several theories have been advanced. Careful perusal of the literature revealed no case complicated by pregnancy. For this reason, and because of its interest, the following case is reported.

CASE REPORT

Mrs. W. C., secundigravida, primipara, aged twenty-six, was seen on August 4, 1936, complaining of weakness, exhaustion, and an amenorrhoea of two months' duration.

The history of the patient disclosed a pregnancy four years previously, complicated by exhaustion and weakness, and delivery of a full-term female child after a rather long labor. One and a half years later a "run-down" condition was diagnosed as anaemia. A persistent cough seemed to indicate some lung pathology. Roentgenographic examination, however, disclosed no lung pathology, but a very curious pathology in the bones comprising the thoracic cage. A complete study of all the bones of the body revealed a generalized osteopetrosis.

Fig. 1

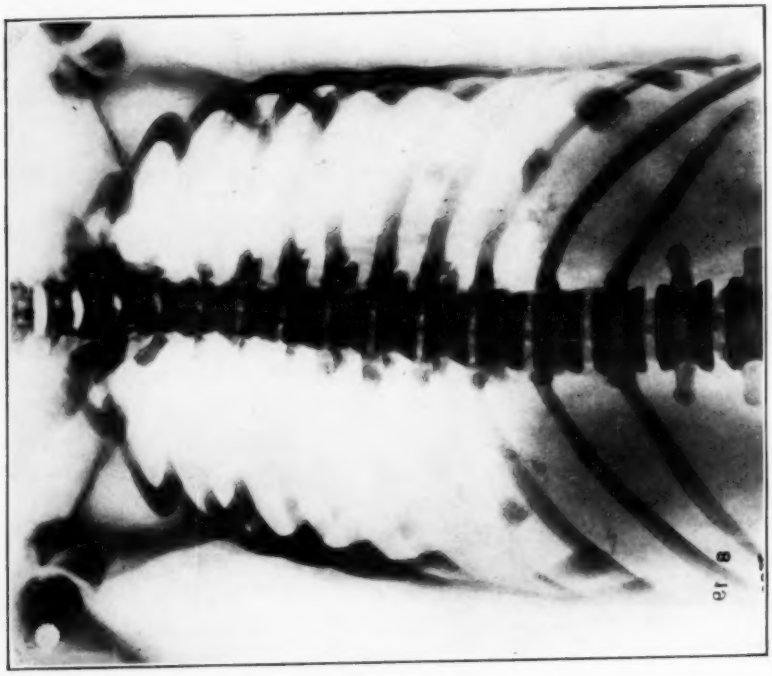

FIG. 3

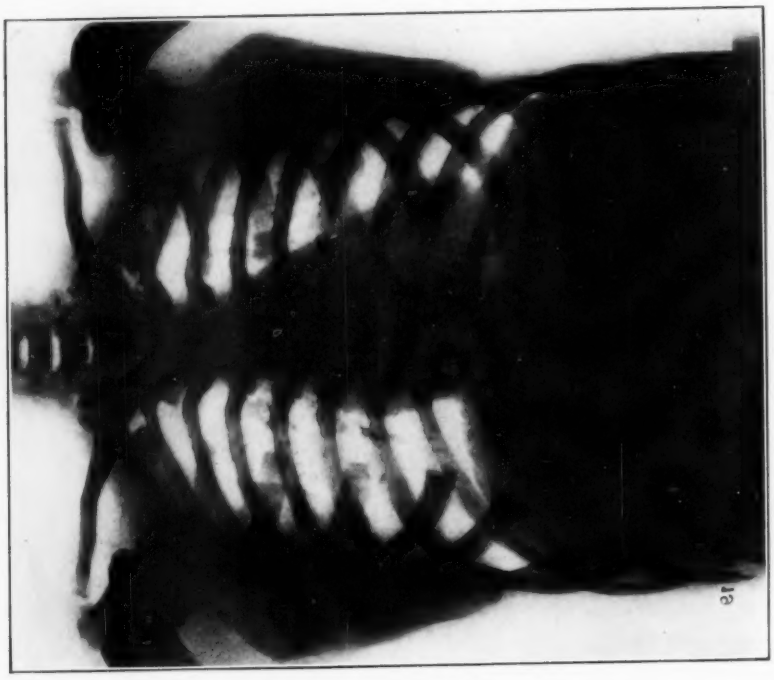

FIG. 2

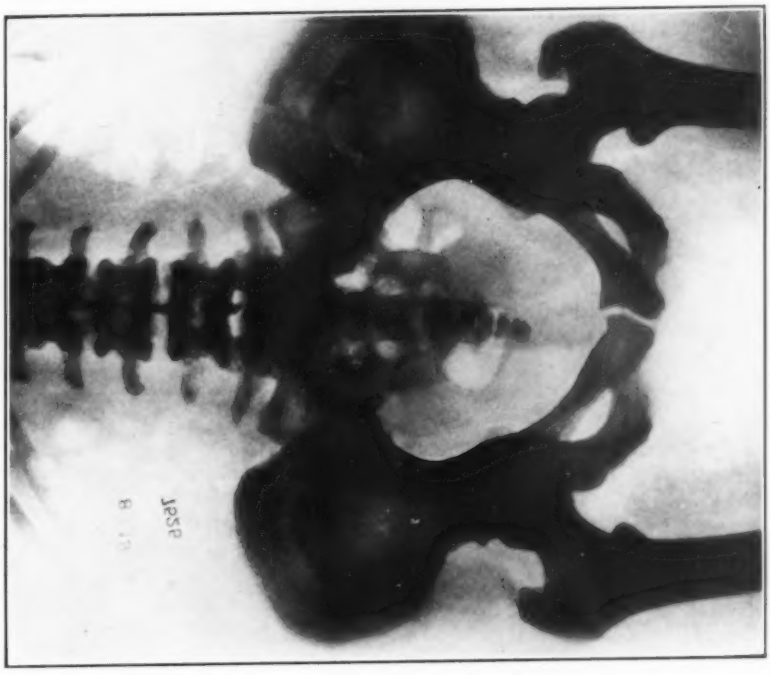

FIG. 6

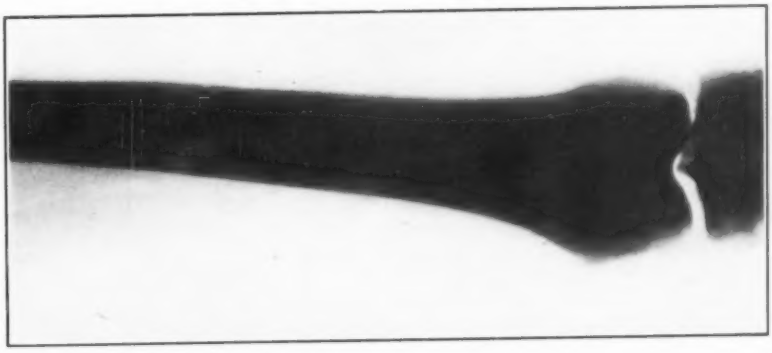

FIG. 5

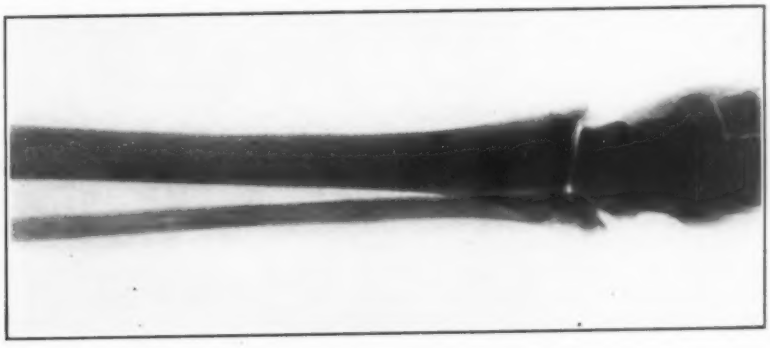

FIG. 4

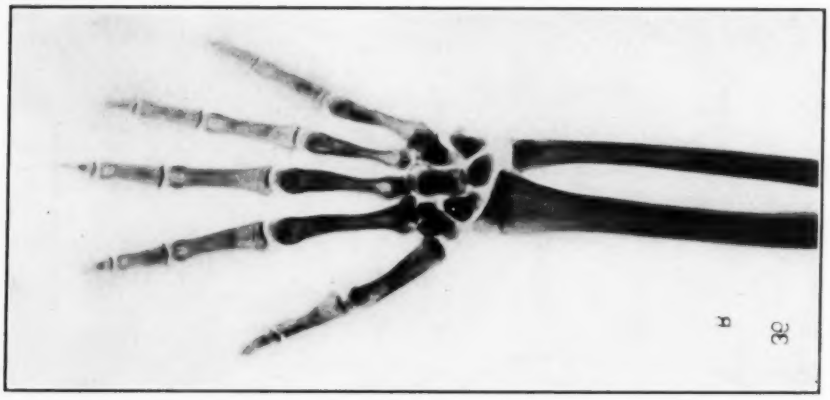

FIG. 7

The patient's familial history was not remarkable. Her father was living and well; her mother died in the early thirties from a heart and kidney disease.

From the time of diagnosis of osteopetrosis until the patient first consulted the author, she had had a number of recurrences of anaemia, which required both intravenous and intramuscular medication as well as oral medication.

On examination, the patient's skin was rather pale; the size of the head seemed larger than normal. There were a few cervical glands palpable just anterior to the sternomastoid muscle. Examinations of the thorax, the heart, and the abdomen were all negative. Pelvic examination revealed the cervix lacerated slightly and to the left, soft, with the typical bluish discoloration of pregnancy. The corpus uteri was markedly retroverted and soft, and was estimated to be about the size normally found after two months of pregnancy. The blood pressure was 98/62.

Laboratory findings showed:

Red blood cells—5,260,000

Hemoglobin—80 per cent.

Color index—.7; mean corpuscular hemoglobin—25 micromicrograms

Mean corpuscular volume—76 cubic microns

White blood cells—12,600

Polymorphonuclear neutrophiles—65 per cent.

Large lymphocytes— 2 per cent.

Small lymphocytes— 32 per cent.

Eosinophiles— 1 per cent.

Coagulation time—2½ minutes; bleeding time—1 minute

Blood phosphates—3.34 milligrams in 100 cubic centimeters of blood; blood calcium—8.8 milligrams in 100 cubic centimeters of blood.

Uncatheterized specimens of urine showed a trace of albumin and a few red blood cells and pus cells.

Roentgenographic studies showed a uniform increase in density of the bones of the skull, with obliteration of the medullary spaces, and a loss of clarity of the suture lines. No mastoid cells appeared; both anterior and posterior clinoid processes were very dense, with no bridging (Fig. 1). The ribs (Fig. 2), all the bodies of the spine (Fig. 3) and long bones (Figs. 4 and 5), and the bones of the pelvis (Fig. 6) showed a homogeneous increase in density throughout, with loss of all detail and obliteration of the medullary spaces. The metacarpals, and to a lesser degree the phalanges (Fig. 7), were beginning to show some of the changes. The diagnosis was osteopetrosis.

Inasmuch as this condition is a familial, hereditary disease, observers are agreed that pregnancy is contra-indicated. For this reason, a hysterotomy was done with removal of the foetus and sac intact. Sterilization by resection and ligation of the fallopian tubes, a

suspension of the uterus, and an appendectomy were done. The patient made an uneventful recovery and has since left the city.

At the University of Nebraska College of Medicine, microscopic sections of the foetus were made, but it was too small to show any important osteogenetic changes.

DISCUSSION

The consensus of opinion is that osteopetrosis is a hereditary, familial disease, the course of which is chronic, progressive, and unresponsive to treatment.

Pregnancy is contra-indicated; termination of pregnancy and sterilization are, therefore, advisable.

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TRAUMATIC MALACIA OF CARPAL BONES

A Case Report

BY C. W. BRAINARD, M.D., BATTLE CREEK, MICHIGAN

Repeated trauma may result in alterations in the carpal bones which simulate the clinical changes in the forefoot in the so-called "march foot". Köhler has given a lucid description of the roentgenographic changes present in the lunate, occasioned by occupational compression injuries. This was first described by Kienböck in 1910, and is designated traumatic malacia, or Kienböck's disease.

CASE REPORT

O. M., white, male, aged twenty-eight years, a mill worker, was seen on August 13, 1934. He stated that five days prior to examination he had noticed a painful swollen left wrist. There was no history of accident, and his general health was excellent. The usual home treatment had been instituted with no success, and increasing pain and swelling caused him to seek medical advice.

Questioning brought out the fact that the patient's occupation consisted of keeping the flow of corn through a pipe in the floor of a bin from interruption by clogging. This was done with a metal bar, tamping the kernels through the opening of the pipe, the impact of the blow being at the base of the palm, and was estimated by the patient to be as

FIG. 1

Roentgenogram showing loss of contour of the carpometacarpal articulations of the lesser multangular, the capitate, and the hamate, and a decalcification of the distal borders of the carpals and the proximal ends of the metacarpals.

frequent as twenty times an hour. This occupation had been followed for two years before the onset of symptoms.

Examination was essentially negative except for the left wrist which was swollen and tense, more particularly on the dorsum, with no evident redness or heat. Motion was limited and painful, particularly in palmar flexion. Palpation elicited extreme pain on both dorsal and palmar surfaces with no evident localization.

Roentgenographic examination (Fig. 1) showed a loss of the contour of the carpometacarpal articulations of the lesser multangular, the capitate, and the hamate, and a decalcification of the distal borders of the carpals and the proximal ends of the metacarpals. In comparison with roentgenograms of the right wrist, those of the left wrist showed an osteoporosis of all of the carpal bones, particularly the navicular which showed a small area of cystic degeneration on its mesial border.

FIG. 2

Roentgenogram showing complete restoration of the joint surfaces. The decalcification process has been arrested and bony trabeculations are evident throughout the bodies.

Treatment consisted of immobilization in a circular cast with t! e wrist in the cock-up position. The swelling and pain disappeared in a relatively short time, and in six weeks a cock-up splint was applied. Improvement was gradual, pain in palmar flexion being the last symptom noted, and, on December 3, a further roentgenographic study (Fig. 2) was made, which showed a complete restoration of the joint surfaces. The decalcification process was arrested and bony trabeculations were evident throughout the bodies. The cystic degeneration of the navicular was not in evidence, and complete restoration of the bony contour was noted.

The patient returned to his former occupation with directions as to the proper use of his hand and wrist, and has had no return of symptoms.

This condition can well be due to compression injuries, producing a disturbed nutrition of bone similar to the repeated trauma of inordinate weight-bearing which is thought to cause the painful swelling of the forefoot in the so-called "march foot", with its attendant bone changes in the metatarsals. In this case immobilization was sufficient to effect relief of symptoms, and the roentgenographic appearance was such as to warrant an optimistic viewpoint as to the ultimate complete recovery.

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MULTIPLE CONGENITAL DISLOCATION

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From Kasr-El-Aini Hospital

Congenital dislocations are extremely rare in Egypt. During the course of several years a large hospital may admit only one or two patients with congenital dislocation of the hip. As often happens when a disease is rare in a locality, the cases encountered are often of the severer types. Among the very few cases seen, the majority were bilateral, and congenital dislocations of both knees were as common as those of both hips: whereas in other countries the former lesion is extremely rare as compared with the latter. The rare types of congenital dislocations occur about as frequently as in other countries. No explanation is forthcoming.

The following case is sufficiently unusual to warrant its being reported.

The patient, a girl, was seen about a week after birth. There was nothing abnormal in the delivery and a previous child was perfectly healthy. No other members of the family had ever had any similar trouble. Roentgenographic examination (Figs. 1 and 2) showed dislocation of the hips, the knees, the tibiofibular joints, the elbows, the radio-ulnar joints (proximal and distal), and the shoulders. Correction of the knees was started at once, with definite improvement in a month. The patient died at about the age of three months and was reported to have had a very indefinite lump in the abdomen.

FIG. 1

Multiple congenital dislocations. Both hips, knees, and tibiofibular joints (proximal and distal) are dislocated.

Apart from its interest as a very rare condition, this case is such as to cause one to reconsider the etiology of congenital dislocations. Abnormal positions can hardly be expected to separate the

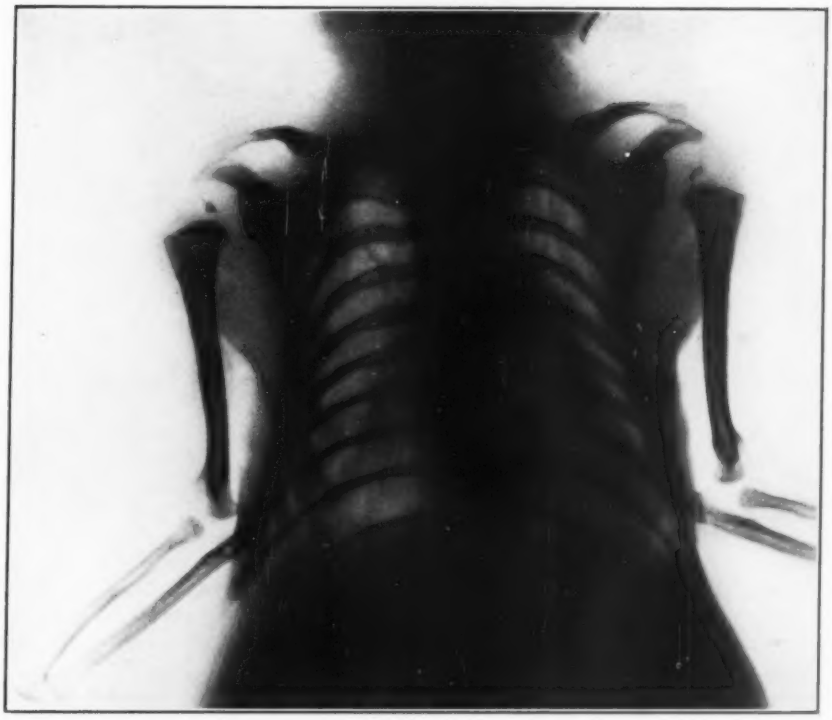

FIG. 2

Multiple congenital dislocations. Both shoulders and radio-ulnar joints (proximal and distal) are dislocated.

radio-ulnar and tibiofibular joints. It seems very likely that there is an inherent defect in the mesenchyme which causes such multiple and universal lesions.

FRACTURE OR EVULSION OF THE ANTERIOR SUPERIOR SPINE OF THE ILIUM

BY E. N. CLEAVES, M.D., BOSTON, MASSACHUSETTS

Fracture or evulsion of the anterior superior spine of the ilium is not a very common occurrence. According to Dr. Voigt Mooney of Pittsburgh, there have been fifty-eight cases reported. Dr. Mooney added two more cases, bringing the total to sixty. The author wishes to report two cases which have come under his observation.

CASE 1. T. W., a well-developed, white boy, eighteen years of age, was playing touch football on November 14, 1935. He caught a pass and ran seventy-five yards, when he felt pain in the right groin. He had experienced similar pain before, and had called it "a muscle pull". The pain persisted for several days, and then completely disappeared. On November 22, he felt entirely well, and again played touch football. He received a kick-off and ran eighty yards to the goal line. Just at the goal line, he felt a "sudden crack" or "sense of something giving way" on the right side in the region of the anterior superior spine. His leg buckled under him and he fell, landing on the left hip. There was immediate marked pain in the right side of the pelvis and the right leg. The patient got up, walked around with a limp, but continued in the game for about twenty minutes, although he did not run. After taking a shower, the patient tried to go down some steps, and felt very acute pain. He then had to be carried to the infirmary, where he was placed in a plaster spica. He had an uneventful recovery in from six to ten weeks.

CASE 2. T. S., a well-developed, white boy, seventeen years of age, was injured by a sudden twisting motion, while playing football. There was no direct violence. Accom-

FIG. 1

Case 1

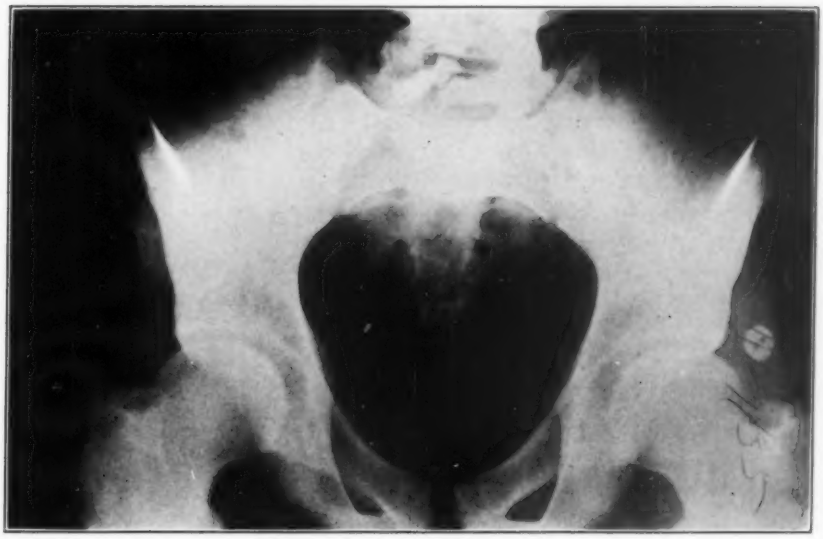

FIG. 2

Case 2

panying the twist, there was sudden, severe pain in front of the hip. The patient was able to walk, although with some degree of discomfort. Treatment consisted of the application of a figure-of-eight bandage; no plaster was used. An uneventful recovery followed.

These two cases are typical of this lesion. It usually occurs during adolescence, in boys or girls who are engaged in athletics. The patient experiences sudden severe pain in the region of the anterior superior spine of the ilium, following strenuous muscular effort or a sudden unguarded movement. The roentgenogram is quite typical. Complete recovery is the usual result.

FRACTURE OF THE FIRST RIB UNASSOCIATED WITH FRACTURES OF OTHER RIBS

A Case Report

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From The Guthrie Clinic, The Robert Packer Hospital, Sayre, Pennsylvania

Fractures of the first rib are stated to be very rare by most texts and, as a matter of fact, are seen very infrequently in routine traumatic work. Recently Breslin has reported five cases of fracture of the first rib with a review of twenty-seven other cases which he found in the literature, along with a discussion of the anatomy, mechanism, pathology, symptoms, complications, and treatment. He emphasizes the fact that, although fractures of the first rib are rare, their presence should be considered in patients who complain of a "sticking pain" in and around the shoulder region, particularly in those patients who, after severe trauma, do not show signs of fracture of the neck, clavicle, or humerus.

Regarding the mechanism, Lane, the English anatomist, has suggested that fracture of the first rib may occur only in one of three ways: (1) as the result of indirect violence, the force being transmitted through the clavicle; (2) directly by means of force applied behind; or, (3) indirectly by force transmitted through the manubrium.

Fracture of the first rib is important because serious complications are liable to develop. The most significant of these are: (1) abscess formation above and below the clavicle; (2) rupture of the apex of the lung; (3) emphysema; (4) pleurisy; (5) hemorrhage; and (6) nerve symptoms which may come on immediately or a few months after the accident when the callus is of sufficient size to encroach upon the nerve pathways. Rebhorn reported one interesting complication of fracture of the first rib,—namely, the development of Horner's syndrome in a male, twenty-one years old, who had suffered a squeezing violence to the upper part of the chest.

Because of the rarity of this fracture and the complications which may develop, the authors wish to record the following case.

W. R., male, twenty-one years of age, was recently admitted to The Guthrie Clinic in shock, having been pinned in the rumble seat of an automobile when the car had crashed into a post. He complained of backache, inability to move the left arm, and difficulty in breathing. Respirations on admission were 48 per minute. Active or passive attempts to flex the neck caused great pain. Expansion was limited bilaterally on admission and many coarse râles were heard over both lung fields on auscultation. The patient did not complain of pain on deep inspirations.

The roentgenogram taken after admission (Fig. 1) showed fractures of the vertebral ends of both first ribs with no displacement of the fragments. A fracture of the lamina

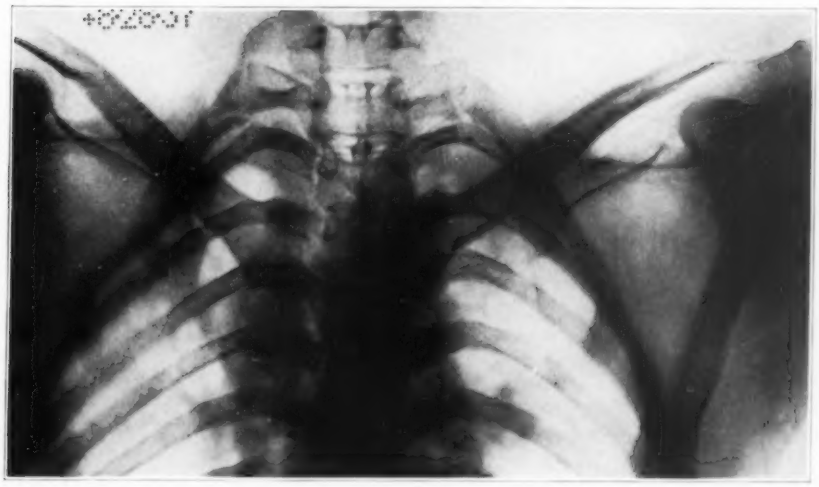

FIG. 1

W. R. Roentgenogram on admission, showing fractures of the first ribs without any alteration of alignment.

of the right side of the second thoracic vertebra was also recorded in the report of this roentgenogram.

The treatment consisted merely of rest in bed for three weeks without any type of fixation, and, after an additional week in the hospital as an ambulatory case, the patient was discharged on the twenty-eighth day after the accident, symptom-free and with no demonstrable physical signs relating to his injuries. He was seen about seven weeks later on a return visit to the Clinic and at this time had no symptoms or signs referable to the fractures.

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A COMPACT PENDULUM ARTHROMETER

BY JOHN G. HAND, M.D., PHILADELPHIA, PENNSYLVANIA

The commercial instrument for measuring the range of joint motions designed in 1918 by Falconer is unsatisfactory for use on children and on small adult joints, because its weight makes it unwieldy and difficult to use accurately. However, such an instrument is of great value in measuring the motions of the extremities, and a compact model will be used daily in the clinic because of its ease of application and rapidity of use.

Excellent service has been obtained in two fracture clinics from a small home-made instrument (Fig. 1) which is readily fitted to a young child's forearm, hand, or foot. It is made from an ointment box and is constructed without technical finesse, as follows:

A one-ounce ointment box is fastened to a strap by riveting, or construction of a metal slot soldered to the back, as shown in Figure 2. A dial, graduated in 5-degree units, half reading clockwise and half counter-clockwise, is glued to the label. (This may be made accurately by photographing to scale a large dial which has been carefully drawn, and using a print of this photograph.)

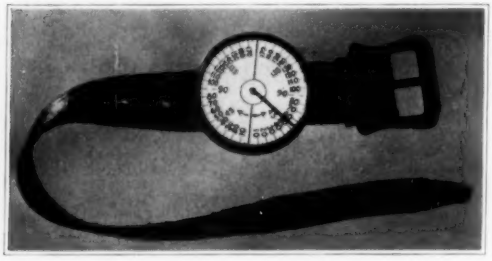

FIG. 1

The arthrometer.

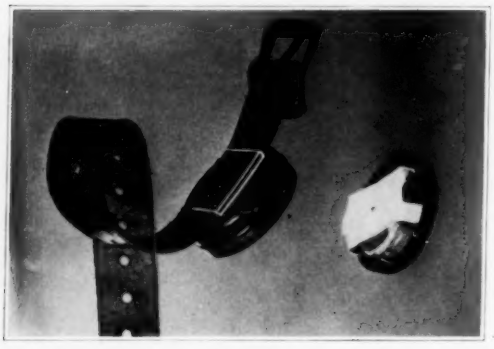

FIG. 2

Rear view of case, showing attachment of strap; and inside of lid, showing mounting of pendulum.

A pendulum is then constructed by casting about thirty grams of lead in a quadrant-shaped mold and incorporating a piece of steel music wire, bent as shown in Figure 3. The caliber of the wire is about five-hundredths of an inch, and the wire serves as an axle for the weight and as an indicator for the dial. The indicator arm should be ground to a point and painted black.

The pendulum-pointer unit is passed into a hole, drilled in the center of the lid of the ointment box, from within, so that the pointer is outside, the weight inside, and the unit held in this position by a bearing made of tin, soldered to the back of the lid. The

axis of the bearings should be vertical to the face of the lid, so that the pointer does not scrape the dial anywhere in its travels. The rear end of the axle must not be so long as to bear on the inside of the box when the lid is pressed into place.

The weight of the completed instrument is about three ounces.

FIG. 3

The parts of the arthrometer. An extra pointer has been included to show the shape of the wire without the lead casting.

In use (Fig. 4) the instrument is strapped to the part distal to the joint to be measured, and the limb is arranged so that rotation about the joint occurs in a vertical plane. The parts are fixed at any given angle (straight, at a right angle, etc.) and the dial is set at a corresponding reading by twisting the lid on the box. The operator then fixes the part proximal to the joint with one hand while he steadies the instrument and guides the patient with the other. Care must be taken to see that the muscle and soft-tissue movements do not cause the instrument to rotate slightly on the part. The measuring process should be repeated two or three times until the operator is satisfied that he has an accurate reading.

FIG. 4

Showing the use of the arthrometer to indicate the range of motion in the elbow joint.

The instrument has been especially useful in determining the return of elbow-joint function following fracture of the lower end of the humerus, but with more or less ingenuity it can be used for most of the other motions of the body.

A METHOD FOR SKELETAL TRACTION TO THE DIGITS

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LOS ANGELES, CALIFORNIA
From the Department of Orthopaedic Surgery, College of Medical Evangelists

The use of skeletal traction has rapidly become an accepted procedure in the treatment of fractures. Its application to the fingers has progressed somewhat more slowly. Too often the size of the transfixing pin is out of proportion to that of the phalanx. There is also the problem of how best to fix the traction to the pin. For these reasons the less complicated methods for applying traction to the fingers—such as adhesive plaster, celluloid dressings, fingernail traction, and pins through the pulp of the finger tip—have been in vogue. The most efficient, as well as the most comfortable type of traction, especially where considerable pull is necessary, is that applied directly to bone. More general use of skeletal traction to the fingers and toes would no doubt result were there an easy and simple method of application.

The apparatus which the authors have devised for this purpose consists of a wire of minimal size, an ordinary small Yankee drill such as may be purchased in any notion store, and a simple C clamp. The wire is stainless steel of the smallest size—8-gage piano wire such as is usually sold for the Kirschner outfit. This wire is cut to appropriate lengths and on one end of each is made a drill point. Tonsil-snare wire may be used, but of course this is not stainless. The drill is a cheap variety of the Yankee drill. A small tunnel may be made deep to the chuck to take up further length of the wire. When using the drill it is better to employ an alternating motion than to keep jerkily trying to turn it in a continuous circular manner. The C clamp is made of 8-gage spring-steel wire. Each prong is drilled one-sixteenth of an inch from the end in the axis common to both prongs a little larger than the wire it is to receive. The wire may be inserted through any phalanx, but in general a point should be used as close as possible to the lesion.

After the skin has been sealed with tincture of benzoin and gauze, the ends of the wire are cut to the required length and turned back 180 degrees with a Kelly clamp or a prong of the C clamp itself. The wire is then ready for the application of the C clamp which supplies the tension to keep the wire taut. This is facilitated by the use of a pair of ordinary slip-lock pliers or medium-sized hemostats to hold the tension of the C clamp while hooking it onto the wire. The manner of hooking the wire is shown in Figure 1. In turn, traction is made on the clamp through rubber bands which are secured to the usual banjo splint or to a hooked wire embedded in a plaster cast.

This method of applying traction to the digits has been used by the authors during the past two years, and has given entire satisfaction

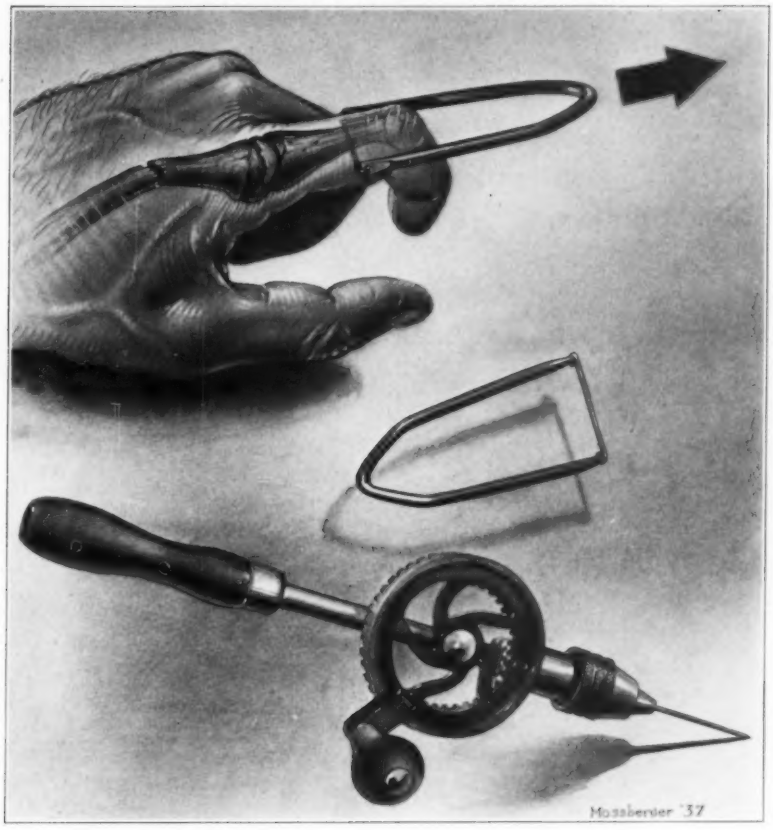

FIG. 1

both in regard to efficiency and the patient's comfort. In addition to oblique fractures and some transverse fractures of the long bones of the hands and feet, fracture-dislocations of the interphalangeal joints have also been reduced and the position has been maintained. In many cases of badly comminuted Colles' fracture, better results can be obtained with traction which can easily be applied by this method through the thumb or the index finger.

THE USE OF "PERIOSTEAL SUTURES" IN OPEN FIXATION OF FRACTURES OF THE TIBIAL CONDYLE

Report of One Case

BY LESTER E. GARRISON, M.D., F.A.C.S., AND MONROE GARRISON, M.D.,
CHICAGO, ILLINOIS

From the Surgical Division of Mercy Hospital, Chicago

It is the purpose of this report to call attention to what might be termed a variation of technique in the operative fixation of condylar fractures of the tibia. The method was discovered somewhat by accident. It will not be applicable to every case, especially to those in which there is a gap between the fragments. Where it can be used, it represents a rapid and easy means of procedure. It greatly shortens operating time and may prevent the rarefaction of bone that too often follows pin or nail insertion. It should not be overlooked in cases that present a patent epiphyseal line.

This technique has been termed the use of "periosteal sutures" largely because of lack of a better name.

CASE REPORT

F. K., male, aged fifteen, was admitted to the Surgical Service of Mercy Hospital on March 26, 1935. On the previous day he had fallen while running, striking the right knee and thigh. He did not recall whether or not the knee had been wrenched. It had been impossible for him to bear weight on the leg immediately after the accident. Swelling had followed at once and, according to the patient's description, it extended from the knee to the ankle.

Examination at the time of admission showed the right knee, lower thigh, and upper leg to be markedly enlarged. A large hematoma was present over the tibial tuberosity and smaller hematomata were scattered about the knee joint. Bony landmarks were obliterated. Because of the great swelling and tenderness, accurate palpation was impossible. After incorporation of the limb in a posterior metal splint, anteroposterior and lateral roentgenograms were taken.

The lateral roentgenogram (Fig. 1-A) showed a fracture extending diagonally from the distal margin of the tibial tuberosity into the subchondral cortex. The fragment was wedge-shaped and included most of the tuberosity. It had been tilted upward by the action of the quadriceps, displacing the patella above the intercondylar groove. The fracture line had followed the growth cartilage and had then broken into epiphyseal bone. The anteroposterior roentgenogram (Fig 1-B) showed elevation of the floor of the lateral portion of the knee joint. The fibula was uninvolved.

The position of the fragments and the displacing force exerted by the upward pull of the quadriceps indicated an open reduction. It was thought advisable to wait for a few days to allow the swelling to decrease. Accordingly, the extremity was immobilized in a short plaster spica to minimize muscle pull. It was hoped that complete avulsion of the fragment might be prevented. During this time, complications developed. The parents refused to believe that a "broken bone" required surgery. As a result, operation was not performed until April 9, or two weeks after the injury.

Under anaesthesia, the knee was again palpated and the fragment was found to lie entirely laterally. Crepitation was pronounced. That attachment to the shaft yet

FIG. 1-A

Lateral roentgenogram showing fracture extending diagonally from the distal margin of the tibial tuberosity into the subchondral cortex.

FIG. 1-B

Anteroposterior roentgenogram showing elevation of the floor of the lateral portion of the knee joint.

FIG. 2-A

Lateral roentgenogram showing firm union, with preservation of the epiphyseal line in the posterior part.

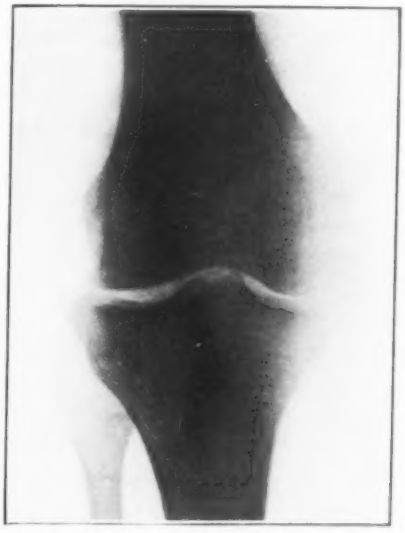

FIG. 2-B

Anteroposterior roentgenogram showing normal alignment.

remained seemed a bit dubious. Upon exposure, a large amount of dense scar tissue, completely covering the fragment, was found. Whether this was evolved from the periosteum, from the joint capsule, or from the surrounding ligaments was not determined. The layer of tissue was the thickness of the little finger and seemed to present

an excellent means of fixation. The fragment was replaced with a mallet. Two mattress sutures of No. 2 chromic catgut were placed through the scar tissue, each in an opposite direction to equalize the pull, and snugly tied. Upon inspection it was seen that normal alignment of the bone was again established. The wound was closed in the routine manner. A long spica cast was applied.

Recovery was uneventful. The patient was discharged on crutches on the ninth postoperative day. Four weeks after operation, the spica was removed and a long leg cast was applied. This second cast was removed in three weeks and the patient was told to use the leg as desired. He was seen again in two weeks, nine weeks from the time of operation. Active flexion to 90 degrees was possible. Passive flexion was not attempted. There was complete extension, but lateral rotation of the foot and leg was limited.

The patient was told to return in one year. He was next seen on July 3, 1936, at which time a second series of roentgenograms was taken. The lateral roentgenogram (Fig. 2-A) showed complete and firm union, with preservation of the epiphyseal line in the posterior part. The anteroposterior view (Fig. 2-B) revealed normal alignment. The former line of fracture was indistinct. All motions were complete. The patient walked well, with complete absence of limping and pain.

DISCUSSION

The report of these rather unusual findings is presented in the hope that it may be of value. We have been unable to find a similar technique in the literature. The formation of anomalous tissue and the ease of operation make one think that it may be advisable to wait ten days or two weeks in all open reductions of fractures of this type.

The derivation of the scar tissue is in doubt. Most probably, it came from the fibrous layer of the periosteum. We confess negligence in not obtaining a piece for microscopic examination, but whether or not this would have revealed any clue as to the origin remains debatable.

We hesitated to use pegs or nails in this operation because of the evident patency of the epiphyseal line. Adequate fixation could probably not have been obtained without piercing the growth cartilage. Although the boy was large and evidently had attained full stature, the upper tibial epiphysis does not completely ossify until the age of nineteen at least. Trauma to a center of possible future growth is surely not compatible with the best surgical technique.

During a recent bit of research (under the direction of Dr. Edward L. Compere of the University of Chicago), it was discovered that drilling the upper femoral epiphyses of experimental animals caused distortion of growth, sometimes so slight as to be visible only on the dissected specimen. Insertion of bone pegs or chips resulted in a more serious disturbance of growth with greater deformity, while curettage of the epiphyseal margins gave what might be called the maximal deformity.

Because of these findings, it was concluded that all surgical manipulation in the region of active epiphyseal lines is to be avoided.

A SIMPLE TECHNIQUE FOR INSERTING THE SMITH-PETERSEN NAIL

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The following simplified technique has been found to be practical and accurate and has been used in thirty femoral-neck fractures. The results have proved that roentgenograms following manipulation, complicated protractor apparatus, and preliminary insertion of guide wires are unnecessary.

The nail length required is calculated as follows: A lead tape, three and one-half inches long, is fastened to the skin just below the greater trochanter of the normal hip and a posterior roentgenogram (Fig. 1) is taken. Since the lead tape and the femoral neck are about the same distance from the film, the amount of distortion is the same, and hence it is easy to figure the length of nail needed.

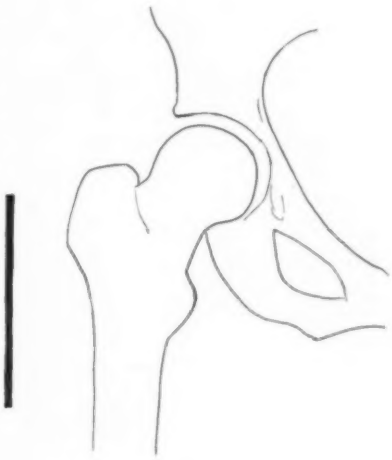

FIG. 1

Tracing of roentgenogram with lead tape, three and one-half inches long, on skin.

The patient is placed on an ordinary operating-room table, with the pelvis resting on a cassette box (Fig. 2), and the fracture is reduced (Leadbetter technique). *No check-up roentgenograms are necessary.* With the extremity held in abduction and internal rotation, a four-inch incision is made, and the origin of the vastus lateralis is exposed and divided for a distance of one inch. A long, stiff wire, bent to the shape of a normal femur, is laid over the lateral aspect of the thigh. The nail is driven in parallel to the short arm of the wire and the floor (Fig. 2). An anteroposterior roentgenogram

FIG. 2

Cadaver resting on cassette box; angle wire in place indicating position of the neck and shaft; nail being driven in parallel to short arm of wire and floor.

is then taken. Without moving the tube, the thigh is flexed 90 degrees. As it comes up into flexion, it is allowed to fall into moderate abduction and external rotation. Another roentgenogram is taken, which is a lateral projection. If the direction of the nail needs to be changed, the nail is extracted and reinserted.

AN INEXPENSIVE, DURABLE WALKING CAST

BY JOHN S. STEPHENS, M.D., LOS ANGELES, CALIFORNIA

By placing a short section of scrap tire on the bottom of a Böhler-type walking cast for an adult or child, one can obtain a soft, durable, non-skid surface for weight-bearing that is not characteristic of the commonly used strap-iron crutch heel.

Figure 1 shows a cross-section of an automobile tire. The outer tread, the rubber side wall, and the bead have been cut away. The uncut half is shown for comparison. Figure 2 shows the flexible side wall incorporated in the completed cast with layers of plaster.

FIG. 1

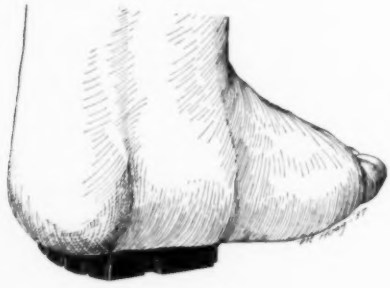

FIG. 2

One should use the smaller type of tire with a thick, unused tread. The wire beads should be removed before the tire is cut into segments with a sharp *oiled* or *wet* knife.

A defective or scrap tire with the beads removed can be purchased for a few cents and can be cut into approximately forty sections, making the cost negligible.

A MODIFICATION OF THE TRACTION TREATMENT OF SACRO-ILIAC STRAIN

BY ALLAN H. WARNER, M.D., WOODSIDE, LONG ISLAND, NEW YORK

In the treatment of sacro-iliac strain and sciatic syndrome, it is sometimes desirable to maintain traction of one or both lower extremities. This is usually done by Buck's extension, attaching a pail of lead shot to the foot through a projecting pulley arrangement.

Since traction need not always be continuous, the patient is ordinarily permitted to get up for bowel movement, and may be allowed other periods of relaxation. The patient cannot conveniently get in and out of the lead-shot and pulley arrangement without help, and it is desirable to have an apparatus which the patient can handle without any assistance.

The following contrivance has been found simple, convenient, and practicable for home treatment.

The inner tube of a tire is placed around the footboard of the bedstead at the level of the upper surface of the mattress. Two loops, about eight inches in diameter and made of canvas tape or a trouser belt, encircle the inner tube perpendicular to its length, between the rungs of the bedstead. The feet of the patient are placed in the loops, so that the tape hooks above the ankles, the calcaneal tubercles, and the toes. The two loops are about eighteen inches apart.

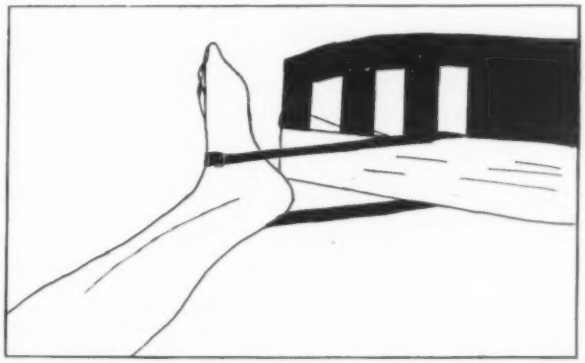

FIG. 1

Showing the strap in position. The strap is prevented from slipping by the forward projection of the tarsal bones and the backward projection of the os calcis.

The foot of the bed is elevated into reverse Fowler's position, and the patient pulls himself toward the dependent head of the bed sufficiently to apply tension on the rubber inner tube. In this way, the patient's body weight opposes the pull of the inner tube.

This position can be maintained for hours at a time without discomfort to the patient. It will usually be found necessary for the patient to pull himself to the head of the bed every once in a while, as the inner tube pulls him the other way.

A SCREW FOR OBLIQUE FRACTURES

BY R. M. YERGASON, M.D., F.A.C.S., HARTFORD, CONNECTICUT

Who has not had difficulty in maintaining reduction of oblique fractures of the tibia? No matter how well these fractures may be reduced and splinted, the calf muscles are so strong that either the fragments slip into overriding or the long superficial point of one fragment is caused to project under the skin by angulation due to spasm in the muscles.

To meet this annoying situation, the author has used the Carrell-Girard screw, which was found to be quite effective; nevertheless, the wood-screw point did not always hold well in the bone, and the selection of the proper drill to use was difficult as the screws vary in size. Furthermore, the thickness of the bone cortex is only sufficient to contact two or three turns of the wood-screw thread, and, in consequence, the grip of this screw is unsatisfactory. It, therefore, occurred to the author to combine the idea of Carrell and Girard with that of Sherman. The Sherman screw has a tap point and machine thread, and the tap point cuts its own thread in the bone. A machine thread, having a much smaller pitch than that of the wood screw, brings a number of turns into the cortex, so that the grip is much stronger.

The screw illustrated in Figure 1 can be procured, cadmium-plated,* at any hardware store, and the cost is negligible. The tap point is easily added by a few strokes of a fine file, and two nuts may be placed upon it in the way in which Carrell and Girard use them.

A curved incision exposes the fracture. The ends of the bones are cleaned and placed in perfect apposition, and held there by any form of bone-grasping forceps (those used by the author are a simple pair of tongs made with flat, curved jaws to grasp the bone). The tongs are held by an assistant. The hole in the superficial cortex is made with a drill just large enough to allow the screw to slip through. The deep cortex of the other fragment is drilled through the same hole with a drill slightly smaller (the size of the drill is determined by the diameter of the screw less its thread). The screw is then inserted and made to engage in the deep cortex by turning it in with a small screw driver; six to eight half turns are sufficient to get a very strong hold in the deep cortex. By means of a tubular wrench, the two nuts are then turned down upon the superficial cortex, one locking the other. The bone-holding forceps are removed, and the wound is closed, allowing the screw to project. The nuts, of course, are buried below the skin, but in the case of the tibia they are quite superficial. The screw is buried in the sterile dressings, and only a light molded plaster splint is necessary.

The patient is allowed up on crutches as soon as swelling has sub-

* Cadmium plate seems to be well tolerated by the tissues. Two screws which have been in a femur for three months look unused.

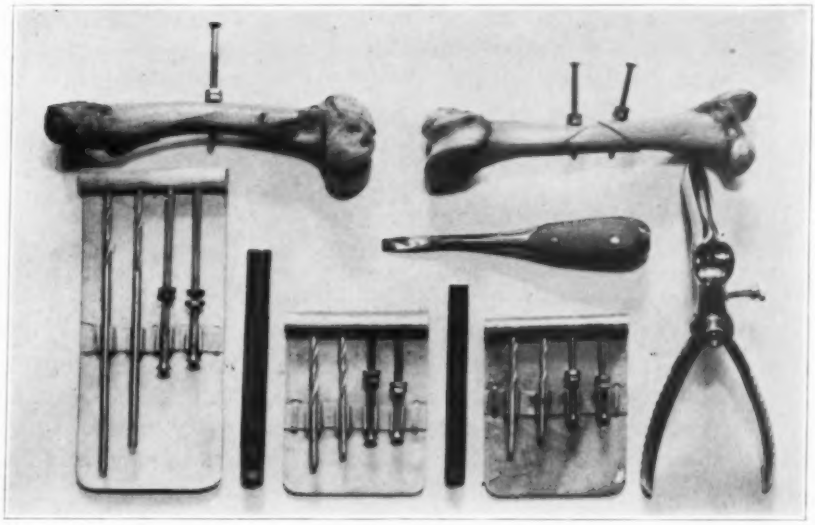

FIG. 1

Showing the three common sizes of screws with their appropriate drills in clips for convenience in boiling, tubular wrenches, small screw driver, and rectal speculum. The two lamb bones illustrate the appearance of the screws in place.

sided, which may be in two or three days after operation. The patient may be discharged from the hospital in a short time and may come on crutches to the office for the removal of stitches. After from two to three weeks, when sufficient callus has appeared and healing of the soft parts about the bone has taken place, the screw may be removed with ease. It will be found necessary to turn the screw out of the deep cortex, which will probably require the use of an artery clamp. Three or four turns loosen the screw from the deep cortex and it can then be withdrawn with the fingers. In such a short time as three weeks the wound will not have healed around the screw so tightly as to make difficult the withdrawal of the screw bearing the nuts.

The author has used this screw in situations where, the nuts being deeply covered by soft parts, the skin has healed around the screw closely, requiring a little nitrous-oxide anaesthesia to open the wound slightly and thus facilitate removal of the screw.

In fractures of the femur, when the line of fracture is toward the wound, it may be best to insert the screw from a different direction. For this, a two-inch incision through skin and fascia allows a bivalve rectal speculum (Sims-Botenhamer) to be inserted. The speculum can be opened enough to permit it to ride astride the bone, and through it the drilling and insertion of the screw are easily accomplished without undue trauma to the perforated tissues. Extra long drills (five inches) are necessary in working through the speculum.

Different lengths of the screw lend themselves to oblique fractures of the femur. In such a fracture near the knee, the fragments are very apt

to kick out of position by the pull of the gastrocnemius and hamstring muscles, and reduction is very difficult to maintain by other methods. There is only one point to be carefully observed and that is to make sure that the drill which is to be used in the deep cortex is just the right size, which is determined by the diameter of the screw less the thread. The drill for the superficial cortex may be a bit large, as the nuts will hold the screw satisfactorily. At the same time, it is best to have this drill just the right size to allow the screw to pass through easily.

Drills supplied by surgical instrument houses, as well as those from hardware stores, all seem to have rather dull points beveled at an angle of 60 degrees. Such drills slip off the bone or migrate sideways when the hole is started. It is a great convenience to have the points reshaped at 30 degrees, which obviates this mishap.

This rather simple open reduction assures perfect maintenance of position with a short period of hospitalization, which markedly reduces the period of disability.

REFERENCES

CARRELL, W. B., AND GIRARD, P. M.: Removable Internal Fixation in Fractures. J. Am. Med. Assn., XCVI, 670, 1931.

SHERMAN, W. O'N.: Compound Fractures of the Femur and Open Fractures into Joints. J. Bone and Joint Surg., VI, 344, Apr. 1924.

SPINAL HYPEREXTENSION LITTER

BY RALPH D. PADULA, M.D., NORWALK, CONNECTICUT

The management of fractures of thoracic and lumbar vertebrae in the last decade has changed considerably with the advent of newer and better methods of transportation. Traffic casualties and disasters have accelerated the number of crushing injuries and fractured vertebrae. Laymen, ambulance drivers, or recent medical-school graduates have little or no practical experience in the application of splints, diagnosis, and transportation of injured.

It is the author's contention that a majority of fractures of the vertebrae are not complicated by cord injuries as a result of the accident, but complications arise from the improper care in handling these patients after the accident. It is a well-known fact that by far the largest number of fractures of the vertebrae are produced by forcible hyperflexion of the bony vertebral skeleton. This induces compression of the anterior portion of the bodies of the vertebrae, with or without torsion and lateral displacement.

In conveying the patient to a hospital, it is very important to keep the back in a hyperextended position from the time of the accident to the final disposition of the case. A patient is moved at least five times from the point at which he is picked up to the taking of the roentgenogram. It is difficult to ascertain when a fracture, not complicated by paralysis immediately after the accident, receives the trauma necessary to cause injury to the spinal cord. Frequently diagnosis of a broken back is not made until paresis of the bladder and paralysis of the lower extremities occur. The fracture then can only be definitely determined as a result of a roentgenographic examination. The axiom which we believe should be followed in the treatment of fractured vertebrae is: "Splint them where they lie."

The mobile hyperextension method of transportation and treatment of the injured causes the patient to be moved only once. Treatment with this hyperextension method consists of forcible reduction of the fracture. Some patients, however, are placed in a hyperextended position and manipulated under general anaesthesia. The fracture is then immobilized in a plaster jacket or plaster spica.

For the past seven years the writer's interest in fractures of the thoracic and lumbar vertebrae has been quickened, with emphasis on the appropriate transportation, diagnosis, and treatment. Dr. George Hawley, of Bridgeport, donated his wide experience in fractures and piloted the author through this work. The old adage, "Splint them where they lie", was unremittingly emphasized by Dr. William Darrach, Dr. Clay Ray Murray, and Dr. Barbara Stimson during the writer's residency at the Presbyterian Hospital. Their views were responsible for his interest in the development of this mobile hyperextension frame.

FIG. 1

Attachment of suspensory band.

This hyperextension frame was designed and fashioned to be permanent equipment in all standard ambulances. This table can be safely strapped to the ceiling without detriment to room and efficiency. It consists of a stretcher, a hoisting frame, a lever frame, and a suspensory band.

The stretcher portion of the frame is seventy-two inches by twenty inches and is made of light, chromium-plated, half-inch steel tubings. It

FIG. 2

Hyperextension of spinal column.

is reenforced on the under side by light steel cross-bars. The ends of the horizontal bars are turned in the shape of a U, which makes a very effective hand grip. The upper surface of the stretcher is made of teakwood, one-half an inch thick, and covered with a one-piece removable pneumatic mattress.

The hoisting frame is twenty inches high and twenty inches wide, and is made of half-inch chromium-plated steel tubings in the shape of an inverted U, with the twin legs of the U fitting into a specially designed fixture. Once the hoisting frame is placed in position, it is capable of withstanding at least 500 pounds of pressure without being displaced in any direction. The rounded end of the U is a continuation of the twin legs of the U, so that it makes a perfect receptacle for the lever frame.

The lever frame is forty-eight inches long and twenty inches wide, and is also made of half-inch chromium-plated steel tubings in the shape of a rectangle with the end bar slightly curved. There are two reenforcing cross-bars made of the same tubing as the rest of the frame. The anterior bar is made to fit into the rounded end of the hoisting frame, premitting thirty inches of the lever frame to elevate the suspensory band.

The suspensory band is made of 18-gage half-hard aluminum sheets, this material being chosen because it bends easily to conform to the contour of the body and for the taking of anteroposterior and lateral roentgenograms. This band comes in different sizes—eight inches by twenty inches, six by eighteen, and four by fourteen—to be used according to the size of the patient.

The hyperextension stretcher is taken out of the ambulance and carried to where the injured person is lying. The suspensory band is slipped under the small of the back, producing a moderate amount of hyperexten-

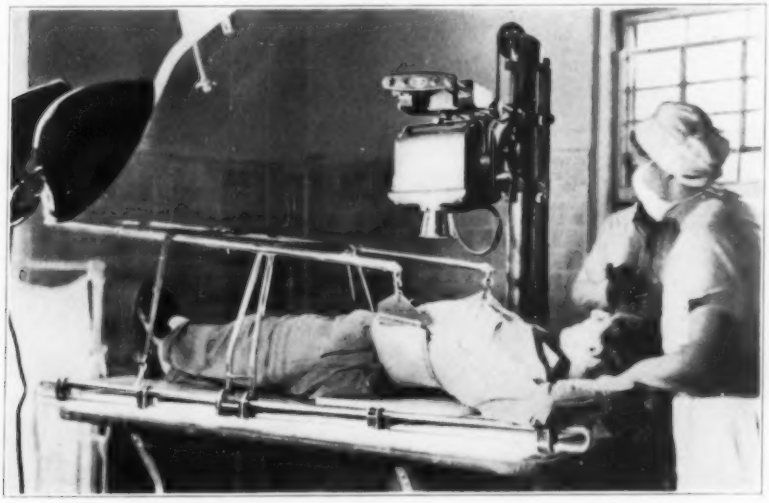

FIG. 3

Showing patient in position for taking an anteroposterior roentgenogram.

sion. With the hyperextension maintained, the patient is gently placed on the stretcher portion of the frame. The hoisting frame is fixed in position on the stretcher. The lever frame is placed in position in the hoisting frame. The suspensory band is attached to the lever frame and, by pressure on the posterior portion of the lever frame, the required amount of hyperextension is produced and maintained by locking the strap between the lever frame and the stretcher. The patient on the hyperextension frame is very easily transported to the ambulance in much the same way that he would be carried on any other stretcher.

SUMMARY

1. The same consideration should be given to fractures of the spinal column as to fractures elsewhere in the body. Restoration of normal bone-and-joint contour of fractured vertebrae is just as essential to restoration of normal function as it is in fractures elsewhere in the body.

2. Fractures of the vertebrae without cord changes can easily be converted into fractures with cord symptoms by improper handling and transportation of a patient to the nearest point where a diagnosis and competent treatment can be obtained.

3. Splinting of fractured vertebrae where the patient lies is just as important as splinting fractures of long bones to prevent serious complications from arising.

4. Early diagnosis, early reduction, and early immobilization of fractured vertebrae are the factors which comprise the ideal care of this type of injury.

5. Delayed cord symptoms, following fractures of vertebrae as a result of hemorrhage, will, in a majority of cases, be eliminated by an early reduction of the fractures. The mechanical reduction of the deformity will usually stop the hemorrhage and prevent delayed spinal-cord paralysis.

6. The mobile hyperextension stretcher frame is so designed and constructed that the patient is moved only once, making it unnecessary to move him again to make the diagnosis, to reduce the fracture, and to immobilize the fracture.

PATRIK HAGLUND

MAY 27, 1870–DECEMBER 8, 1937

Patrik Haglund died suddenly on December 8, 1937, in an attack of angina pectoris, having been occupied earlier in the day with his daily routine of work.

Prof. Haglund was born in Norrköping, Sweden, on May 27, 1870, and began his career by taking a university degree in astronomy and physics. He then transferred to the medical faculty, where he received the degrees of Licentiate in Medicine in 1899 and Doctor of Medicine in 1903. He became a lecturer in Orthopaedic Surgery at the Caroline Institute in Stockholm and was elected Professor of Orthopaedic Surgery in 1913, in which capacity he remained until 1935 when he retired as an Honorary Professor.

Prof. Haglund received his surgical training with Prof. Karl Gustav Lennander, the famous Uppsala surgeon. In him Prof. Lennander found a pupil who, with his mechanical inclination and biological outlook, seemed well adapted to devote his abilities to orthopaedic surgery. This branch of surgery, which at the end of the last century had begun to assume an independent position both scientifically and from the point of view of organization, especially in Germany, had as yet no representative in Sweden. His

orthopaedic training Prof. Haglund obtained mainly from Prof. Albert Hoffa whom he served as an assistant over a long period.

In good times as in bad, and despite opposition, Prof. Haglund went forward imbued with a sole and great idea,—the care and treatment of the crippled. He was the true mainspring of Swedish Orthopaedic Surgery as it presents itself today. As an organizer, he gave evidence of great foresight and had a tremendous influence on orthopaedic treatment in the whole of Scandinavia.

As a scientific writer, he was remarkably productive. His writings number nearly 300 in all. His most important work was *"Prinzipien der Orthopädie"*, published in 1923, an exceedingly original and subjectively colored handbook on the most important chapters in orthopaedic surgery. The whole work may be considered a battle cry against a too one-sided morphological orthopaedic outlook under emphasis of the dominating importance of function.

By those who knew Patrik Haglund he will be remembered as a man of exceedingly kindly disposition, always very helpful to others. He had a very lively intellect and what he liked most of all was to associate with his young assistants, having the mind of youth even in his later years.

News Notes

The eighth **Sir Robert Jones Lecture** was given by Dr. Frederick C. Kidner at the Hospital for Joint Diseases on February 24, 1938. The subject of Dr. Kidner's address was "Congenital Dislocation of the Hip".

Dr. Theodore H. Vinke announces the removal of his office to Suite 709–710 Carew Tower, Cincinnati, Ohio.

Dr. Paul C. Colonna of New York City has been appointed head of the Department of Orthopaedic Surgery at the Oklahoma University School of Medicine. He has moved to Oklahoma City and his office is now at the Crippled Children's Hospital.

The next examination of the **American Board of Orthopaedic Surgery** will be held in Chicago on June 10 and 11, 1938. Detailed information in regard to this examination may be obtained from the Secretary, Dr. Fremont A. Chandler, 6 North Michigan Avenue, Chicago, Illinois.

The **Chicago Tumor Institute,** opened on March 21, 1938, offers consultation service to physicians in the diagnosis and treatment of cancer and radiation facilities for cancer patients. The Institute also proposes to conduct research and to offer training to physicians who may wish to qualify as specialists in the study and treatment of this disease.

The next Congress of the **Czechoslovakian Orthopaedic Society** will be held in Prague early in July 1938, at the same time as the Pan-Slavonic Medical Congress and the Pan-Sokol Railly. At this Congress, Prof. Zahradníček will discuss "Pseudarthrosis" and Dr. Frejka, "Necrosis of Bone".

The **Occupational Therapy Curative Workshop,** with offices at 101 North Jefferson Street, Richmond, Virginia, has recently been established in connection with the Wheeldon Orthopaedic Foundation. This will supplement and aid the work of the Foundation which was incorporated two years ago for the purpose of providing without charge the facilities for treating orthopaedic cases. Dr. Thomas Wheeldon of Richmond has been elected Medical Director.

The **Réunion d'Orthopédie et de Chirurgie de l'Appareil Moteur de Bordeaux** took place in Bordeaux on January 27, 1938. The following papers were presented by members and by guests:

Arthrodesis of the Shoulder by the Method of Leveuf and Bertrand—Dr. E. Papin.
Open Dislocation of the Elbow—Dr. E. Papin.
Resection of the Knee—Dr. R. Charry, of Toulouse.
The Use of the Bone Graft in Pseudarthrosis of the Humerus—Dr. L. Dieulafé and Dr. R. Dieulafé.
An Apparatus to Maintain Extension in Fractures of the Leg—Dr. P. Forton.
Myeloplaxoma of the Horizontal Ramus of the Pubis, Treated by Curettage and Osteoperiosteal Graft—Dr. H. L. Rocher.
Some Syndromes of Multiple Fractures—Dr. L. Pouyanne.
The Danger of Faulty Technique in Osteosynthesis by Plate—Dr. C. Lasserre.
Coxalgia Superimposed on Congenital Dislocation of the Hip Previously Reduced. Fixation of the Hip—Dr. M. Delitch, of Yugoslavia.

The Fifty-Second Annual Meeting of the **American Orthopaedic Association** will be held in conjunction with the Congress of American Physicians and Surgeons in Atlantic City, New Jersey, on May 2, 3, 4, and 5, 1938, under the presidency of Dr. Frederick C. Kidner. Headquarters will be at the Ambassador Hotel. Among the foreign guests expected will be Mr. T. P. McMurray, of Liverpool, England. The tentative scientific program is as follows:

TUESDAY, MAY 3

Morning Session

Scalenus Muscle in Relation to Shoulder and Arm Pain.
Dr. Joseph A. Freiberg, Cincinnati, Ohio.

Osteoporosis.
Dr. Eugene B. Mumford, Indianapolis, Indiana.

An Arthroplastic Procedure for Congenital Dislocation in Children.
Dr. Paul C. Colonna, Oklahoma City, Oklahoma.

Discoid Cartilages or Trigger Knee. Pathology and Treatment.
Dr. Frank R. Ober, Boston, Massachusetts.

Popliteal Cyst (Baker's Cyst). Its Etiology, Pathology, and Treatment.
Dr. Philip D. Wilson, New York, N. Y.

Afternoon Session

Symposium on Bone Tumors:

A Review of the Classification of Bone Sarcomata.
Dr. James Ewing, New York, N. Y. (By invitation.)

Analysis of 150 Bone Tumors.
Dr. Robert D. Schrock, Omaha, Nebraska.

Giant-Cell Tumor of Bone.
Dr. Bradley L. Coley, New York, N. Y. (By invitation.)

The Results of Treatment of Osteogenic Sarcoma.
Dr. Henry W. Meyerding, Rochester, Minnesota.

WEDNESDAY, MAY 4

Morning Session

True Idiopathic Sciatica. An Effective Method of Treatment.
Dr. Gilbert E. Haggart, Boston, Massachusetts.

A Further Study of the Head and Neck of the Femur in the Growing Child.
Dr. W. Eugene Wolcott, Des Moines, Iowa.

Aseptic Necrosis of the Head of the Femur, Following Traumatic Dislocation.
Dr. Frank N. Potts, Buffalo, New York.

Presidential Address.
Dr. Frederick C. Kidner, Detroit, Michigan.

Osteo-Arthritis of the Hip.
Mr. T. P. McMurray, Liverpool, England. (By invitation.)

THURSDAY, MAY 5

Morning Session

Symposium on Non-Paralytic Scoliosis:

Non-Paralytic Scoliosis. Principles of Treatment and Non-Operative Management.
Dr. Arthur Steindler, Iowa City, Iowa.
Dr. W. R. Hamsa, Omaha, Nebraska. (By invitation.)

The Treatment of Scoliosis with the Bent Jacket and Spine Fusion.
Dr. Alan DeForest Smith, New York, N. Y.

The first Executive Session will be held on Tuesday, May 3, at 12:00 noon, and the second Executive Session will take place on Thursday, May 5, at 12:00 noon.

On Tuesday evening, May 3, there will be a reception for the members of the American Orthopaedic Association and the Congress of American Physicians and Surgeons, and the President of the Congress will give an address.

On Wednesday afternoon, May 4, there will be a joint session of the Association and the Congress, and on Wednesday evening the Annual Dinner of the American Orthopaedic Association will be held at the Ambassador Hotel.

The Twentieth Congress of the **Société Française d'Orthopédie et de Traumatologie** will be held in Paris on October 7, 1938, at the *Faculté de Médecine de Paris*, under the presidency of Prof. H. L. Rocher, of Bordeaux. The subjects to be discussed are: "Painful Vertebral Kyphosis Due to Dystrophy" and "Simultaneous Fractures of the Shafts of Both Bones of the Forearm".

The Society will visit the orthopaedic centers of the important cities of Switzerland at the end of September 1938.

The Twenty-Third Annual Meeting of the **Association of Industrial Physicians and Surgeons** will be held concurrently with the Second Annual **Midwest Conference on Occupational Diseases** on June 6 through 9, 1938, at the Palmer House, Chicago, Illinois. The President of the Association of Industrial Physicians and Surgeons is Dr. R. R. Sayre of the United States Public Health Service. Scientific and technical exhibits will be an important feature, and information in regard to the exhibits may be obtained from Mr. A. G. Park, Convention Manager, 540 North Michigan Avenue, Chicago, Illinois.

The Eighth **Internationaler Kongress für Unfallmedizin und Berufskrankheiten** will be held in Frankfurt am Main on September 26 to 30, 1938, under the presidency of Prof. Dr. Martineck. The leader of the Section on Industrial Medicine will be Prof. Dr. Magnus of Munich, while Dr. Koelsch, also of Munich, will conduct the Section on Occupational Diseases.

The subjects to be discussed by the Section on Industrial Medicine will be affections of the peripheral nerves and foot injuries.

Further information may be obtained from Dr. Bauer, 13–15 Unter den Linden, Berlin W 8.

The Fourth International Exhibition of Cripples' Work was held at Edinburgh on October 14, 15, and 16, 1937, under the auspices of the **Central Council for the Care of Cripples.** Sixty-six organizations took part in this exhibit, including one from Canada, one from South Africa, one from Labrador, two from Australia, and four from the United States. The Exhibition was divided into two sections—Adults and Children—and the standard of work displayed showed a marked advance over that of the 1934 Exhibition. Doctors, teachers, and others interested in the care of cripples visited the stands and attended the film displays, lectures, and demonstrations.

The **American Physicians' Art Association,** a national organization of medical men who have ability in the fine arts, will hold its first national exhibition in the San Francisco Museum of Art, San Francisco, California, in June 1938. This first annual exhibition promises to be of unusual interest with entries to be accepted (after jury selection) in the following classifications: oils, water colors, sculpture, photography, pastels, etchings, crayon and pen and ink drawings (including cartoons), wood carvings, and book bindings. Scientific medical art work will not be accepted. All entries close April 1, 1938. Further information may be obtained from the Secretary of the American Physicians' Art Association, 521 Flood Building, San Francisco, California.

The Spring Meeting of the **British Orthopaedic Association** will be held in London and Oxford on May 27 and 28, 1938.

The Annual Meeting will be held in Birmingham toward the end of October.

At a recent meeting of the Executive Committee, the following orthopaedic surgeons were elected to Associate Membership in the Association:

Mr. F. G. Badger, 4 Plasturton Gardens, Cardiff, Wales.
Mr. J. Barnes, Wingfield Morris Hospital, Headington, Oxford.
Mr. David Brown, Royal Infirmary, Sunderland, Durham.
Mr. A. L. Dawkins, 70 Halton Street, Kensington Park, Adelaide, South Australia.
Mr. L. Gillis, Royal Liverpool Children's Hospital, Liverpool.
Mr. A. J. Helfet, Leasowe House, Leasowe Road, Moreton, Cheshire.
Mr. B. Maken, c/o Standard Bank of South Africa Ltd., 9 Northumberland Avenue, London, W. C. 2.
Mr. P. B. Maroney, 9 Oxford Drive, Waterloo, Liverpool.
Mr. S. Pappworth, 29 Rocky Bank Road, Devonshire Park, Birkenhead, Cheshire.
Mr. L. Plewes, Wingfield Morris Hospital, Headington, Oxford.
Mr. I. S. Smillie, 1 Glencairn Crescent, Edinburgh, Scotland.
Mr. W. H. M. Smith, 33 Park Avenue, Portobello, Midlothian, Scotland.
Mr. V. C. Snell, Letchmore Heath, Watford, Herts.
Mr. Kenneth Stanger, Sydenham Terrace, Newcastle-on-Tyne.
Mr. G. E. Thomas, Royal Southern Hospital, Liverpool.

In answer to inquiries in regard to physiotherapists, *The Journal* is glad to offer the following information:

The **American Physiotherapy Association** was organized at the close of the World War, its charter members being former Reconstruction Aides in service. One of its purposes is to "cooperate with and work only under the prescription of members of the medical profession". At present, it has a membership in excess of 800.

The requirements for membership, which have been approved by the Council on Medical Education and Hospitals of the American Medical Association, are: (1) an improved course in physical therapy of not less than nine months, following graduation from a school of nursing or physical education which meets the requirements of the individual states; (2) one year's practice in physical therapy within two years of graduation from an approved school of physical therapy. This standard enables the Association to provide to hospitals, schools for crippled children, and offices of physicians fully equipped and trained physiotherapists who are able to follow the physician's orders intelligently and thoroughly.

Those requiring this service should apply to the Secretary of the Association, Miss Edith Monro, 483 Beacon Street, Boston, Massachusetts.

Correction

In the article on "A Histopathological Study of the Synovial Membrane with Mucicarmine Staining" by James H. Cherry, M.D., and Ralph K. Ghormley, M.D., published in the previous issue of *The Journal* (Volume XX, page 48, January 1938), reference is made to the work of Dr. David H. Kling and also to that of Dr. E. S. J. King. The omission of the letter "l" in the final proof of this paper not only causes confusion, but also robs Dr. Kling of the acknowledgment of his work which the authors intended to make.

The first sentence of the second full paragraph on page 49 should read: "In 1931, Kling investigated the synovial fluid from the standpoint of viscosity and colloidal phenomena and was able to extract the mucinous substances."

Current Literature

LA HERNIE POSTÉRIEURE DU MÉNISQUE INTERVERTÉBRAL (HERNIE NUCLÉAIRE POSTÉRIEURE) ET SES COMPLICATIONS NERVEUSES. Pierre Glorieux. Paris, Masson et Cie, 1937. 40 francs.

This work adds, in a particularly clear and convincing way, to the present knowledge on this subject which is now attracting considerable interest and in regard to which there is need of so much further study, both in respect to diagnosis and to treatment.

The author gives a description of the normal anatomy of the nucleus pulposus and the mechanism of the various forms of its protrusion. He has endeavored to show that the lesions can be demonstrated before operation *in vivo* and that the manner of the protrusion of a portion of the nucleus can be established, which disproves the statement so often made that these lesions cannot be demonstrated with any degree of certainty before operation or autopsy.

He lays stress on the importance of the technique of taking roentgenograms and particularly on the management of lipiodol and the position of the patient while the roentgenograms are being taken. The behavior of the fluid as influenced by the position of the body and by change in posture is described, also the changes in the intervertebral disc consequent to the hernia of the nucleus pulposus. The author applies the results of his studies to the clinical consideration both in regard to diagnosis and to treatment.

Illustrative cases are presented in detail, accompanied by excellent roentgenograms taken after injection of lipiodol.

The diagnostic evidence and the value of the physical signs are clearly shown and carefully discussed. The clinical symptoms, however, are not constant or characteristic. It is demonstrated that these herniae are found at autopsy without any history of symptoms. Their origin may be traumatic or non-traumatic. The roentgenographic findings are definite. The author discusses the relation of this evidence to the clinical signs found in the various regions of the spine—cervical, thoracic, and lumbar—and also to the portion of the canal in which the hernia is found, together with the appearance of the disc and the behavior of the lipiodol as influenced by these various regions. There are charts and line drawings to demonstrate the varieties of herniae in each type as influenced by the different positions of the body.

The clinical evidence is considered under the divisions of static symptoms and nerve symptoms and the general reactions and development of the nerve root and central nervous system. The clinical evidence varies greatly both in character and in degree, and it is known that there are no symptoms in many cases in which definite hernia exists. A discussion of bone lesions and fractures with which these herniae are associated, with a consideration of the diagnosis and treatment, completes the volume. Especially interesting are some of the observations as to the indications for operative or non-operative interference.

The author gives the following findings from his investigations and experience:

1. The posterior nuclear hernia does not necessarily present clinical evidence.
2. The symptoms may be purely static.
3. With the static syndrome there are nerve symptoms which, in those cases in which the hernia is in the cauda equina, are purely peripheral or, when the hernia is present in the regions above, are more generally radicular and medullary. The nerve symptoms may be retarded even in the traumatic cases.
4. Neither the static symptoms nor the nerve symptoms are alone distinctly characteristic.
5. The roentgenographic evidence in the lumbar region may be indicative of bilateral hernia and may show dumb-bell or bead formation which is pathognomonic.
6. Unilateral lumbar hernia and all antemedullary herniae do not give a character-

istic appearance. In these conditions, a definite conclusion of hernia cannot be reached except when the defect shown by the lipiodol is seen opposite a narrowed intervertebral disc.

7. The fact of the existence of one or more nuclear herniae does not signify any relationship between the hernia and the eventual static or nerve syndrome. This must necessarily be established by a comparison of the roentgenographic and clinical findings. If the roentgenographic findings do not present the necessary neurological evidence, a competent neurologist should be consulted.

The book is evidently the result of long experience and careful study of this subject which is comparatively new and on which much of the information has been more or less fragmentary. In addition to his own extensive experience, the author has reviewed the work and opinions of others and has put the subject on a much more definite basis. He has, in particular, contributed to the knowledge which will enable a more accurate diagnosis of hernia, and has done much to disprove the frequent statement that these herniae cannot be determined with any surety *in vivo*.

CHARTERHOUSE RHEUMATISM CLINIC ORIGINAL PAPERS. Vol. I. New York, Oxford University Press, 1937. $6.75.

The first paper, by Dr. Crowe, takes up the pathogen-selective culture of infective organisms in chronic rheumatic diseases, using a modification of the original Solis-Cohen technique. This procedure unquestionably has very considerable value in determining immunological resistance to an infecting organism, but we feel that there is a fallacy in the technique, as lack of resistance to a pathogen does not necessarily prove infectivity.

The classification used is a rather complicated one but seems, in the main, to be based on sound principles, and the subpatellar crepitus, which Crowe stresses, is unquestionably a valuable diagnostic sign.

The second paper, by Harry Coke, on the differential sedimentation test is an attempt to show the value of the procedure, both as a diagnostic test and as an index to success of treatment. The principle is based on the fact that serum is a colloidal solution, the major constituents being serum albumin and serum globulin. In the presence of a flocculating substance, the solution can be precipitated, depending on (1) the pH volume of the menstruum, (2) the action of the flocculent matter, and (3) the composition of the serum. The albumin-globulin ratio is altered in certain pathological states and especially in infections. In the ordinary sedimentation test, red blood cells are used as the flocculent material, but, in the differential sedimentation, vanadic acid is employed and there occurs precipitation by the colloidal solution carrying a negative charge in acid and a positive charge in an alkaline medium. Since the globulins are more easily neutralized and precipitated than the albumins, the albumin-globulin ratio furnishes an index in pathological conditions. The test would seem to be well worth further investigation.

S. Gilbert Scott's report on spondylitis adolescens with associated pathological changes in the sacro-iliac joints is an interesting one, showing that sacro-ilitis is the first roentgenographically demonstrable symptom of spondylitis adolescens. The actual roentgenograms, which the reviewer had the opportunity of examining, show the existence of this condition much more clearly than is demonstrated by the small reproductions in the book. It would appear that this finding is of distinct value as an early diagnostic sign.

DIE ANGEBORENEN FEHLBILDUNGEN DER MENSCHLICHEN HAND (The Congenital Malformations of the Human Hand). Prof. Walther Müller. Leipzig, Georg Thieme, 1937. 15.50 marks.

An orderly review of the entire subject of malformations of the hand is presented in this 160-page monograph in which emphasis is laid on the biological rather than the morphological aspects. The earlier concept of intra-uterine pressure, amniotic bands,

and nutritional disturbances as causative factors is discredited. Instead, the various deformities are shown to be embryonic in origin with definite hereditary tendencies. What we call malformations are really only variations from usual form. A slight increase or diminution of certain components is common; a gross change, rare.

Classification of deformities is made according to developmental factors as follows:

1. Abnormalities of the anlage of the skeleton.
   a. Numerical variations.
   b. Disturbances of length differentiation.
2. Malformation on the basis of disturbance of the primitive hand plate.
   a. Disturbed development of breadth (syndactylia).
   b. Congenital defects of the primitive hand plate (claw-hand).
   c. Hyperplasia of the primitive soft-tissue plate (localized gigantism).
3. Congenital disturbances of the later development of the hands.
   a. Disturbances of the growth in thickness.
   b. Disturbances of the later growth in length.
   c. Exostoses and enchondromata.
   d. Osteochondritic changes.

The monograph is well illustrated by charts, line drawings, photographs, and roentgenograms. There is an extensive bibliography which includes mostly the German literature, however, and omits such names as Kanavel. It is a reference work which should be available to everyone interested in orthopaedic or plastic surgery.

TEXTBOOK OF EXPERIMENTAL SURGERY. J. Markowitz, M. B. (Tor.), Ph.D., M.S. in Exp. Surg. (Minn.). Baltimore, William Wood & Co., 1937. $7.00.

This pleasingly edited textbook presents in 527 pages and 330 illustrations the operative technique of various procedures in experimental surgery employed by the author at the Institute of Experimental Medicine of The Mayo Foundation. He states that the procedures described, although not inclusive of all that are excellent, will be more or less standard procedures in the broad field of experimental medicine. Laboratory experimentation has become an indispensable factor in the progress of further developments in the field of surgery. The part played by laboratory study in graduate teaching in surgery increases in importance yearly. These two facts alone would justify the existence of a book which records with meticulous care the paths to be followed by both the student and the surgeon in their quest for truth and knowledge.

There is much in the book which the surgeon, as well as the student, may read with profit and to which he should give careful thought. When surgeons are as well informed about physiology as they are about pathology and anatomy, there will be less aimless therapy in such supposedly well-understood conditions as peritonitis, intestinal obstruction, and ascites. The text on these conditions is not only highly informative, but it also stimulates the reader to seek the truth for himself. Provided such experimentation is carried out in proper laboratories, in conjunction with the clinical material available in a teaching hospital, only good can result.

It is obvious that only a small part of surgery can be attained in the lecture room. Skill is due largely to repetition and to experience. Much that is to be learned can be accomplished only through the opportunities provided in the experimental laboratory. To the individual entering the experimental field, this book will be invaluable; to the experienced, although he may in some instances cherish his own pet procedures, it will prove a worthy adjunct. The illustrations and bibliography alone, were they the only virtues, would merit a stamp of approval for this textbook of experimental surgery.

TRAUMATISMES DU PIED ET RAYONS X. MALLÉOLES, ASTRAGALE, CALCANÉUM, AVANT-PIED. Étienne Destot. Ed. 2. Paris, Masson et Cie, 1937. 45 francs.

This second edition of Étienne Destot's work on the importance of the roentgen ray in the treatment of injuries of the foot and ankle has been completed by two of his former

pupils, Dr. E. Gallois and Dr. P. Japiot. Prof. Destot's revision of the first edition was interrupted by the World War and his sudden death in 1918. The results of his remarkable studies and roentgenographic observations during the War have been included in this very thorough and painstaking revision of his original work.

Following the Preface by Dr. Alexis Carrel and Prof. Destot's Introduction, the anatomy and physiology of the foot and ankle are treated in great detail and with exceptional care. Each bone is accorded a full description of its surgical anatomy with special regard to its function and its articulations. Each aspect is considered in relation to the treatment of fractures and injuries.

The discussion of the fractures is grouped into three parts: first, those of the region of the malleolus; second, those of the posterior tarsus; and, third, those of the anterior tarsus. Each type is then considered with reference to its etiology, general symptoms, and roentgenographic appearance. Throughout this work special attention is given to the study of the roentgenograms and the interpretation of the evidence.

In the discussion of the posterior tarsus, the mechanical forces and stresses to which this part of the foot is subjected are considered, with particular emphasis on the influence of these forces on the etiology and treatment of fractures in this region. This is especially true with reference to fractures of the astragalus, which are often neglected because of the great attention paid to fractures of the calcaneum.

The lesions of the anterior tarsus are given little, but at the same time sufficient, space, for they do not play so important a part as the traumatic lesions occurring in the region of the malleolus, with which the book is mainly concerned

The book represents an extensive study of a closely localized area where many lesions occur which are severe in character and difficult to treat. The grouping of these aids in the study both of the etiology and of the treatment, and will be a valuable guide for those who are called upon to treat the traumatic lesions of this region.

A Practice of Orthopaedic Surgery. T. P. McMurray, M.B., M.Ch., F.R.C.S. (Edin.). Baltimore, William Wood & Co., 1937. $5.00.

In a text of 458 pages, Mr. McMurray has succeeded in covering all of the more common orthopaedic disabilities, with the exception of fractures. The book is written in a clear simple style, which holds the reader's attention. There is nothing of the statistical or laboratory approach to the problems discussed. The descriptions of the various entities are those of a practitioner of the art, and the methods of treatment are those which he has found useful. In the main, the teachings of Hugh Owen Thomas and Sir Robert Jones are strictly adhered to. The student and the younger orthopaedic surgeon who wish to know at first hand the teachings and practice of the "Liverpool School" will find this book a valuable source of information.

The illustrations are excellent. Photographs, roentgenograms, and line drawings are all used more profusely than is common in the smaller textbooks.

There are certain features of the book which are open to minor criticism. There is relatively too much space given to the discussion of bone and joint tuberculosis, at the expense of such important subjects as arthritis, disabilities of the low back, and anterior poliomyelitis. In the United States, at least, tuberculosis has ceased to be the subject of greatest importance to the orthopaedic surgeon.

Tendon transplantation in anterior poliomyelitis is a useful procedure in selected cases, particularly in helping to balance the muscle power in feet which require stabilization. The author's statement that transplantation of the peroneal tendon to the inner side of the foot to replace the action of a paralyzed tibial muscle "has been abandoned, as the result of such procedures was always unsatisfactory" comes as a surprise to this reviewer, who has seen many excellent results from peroneal transplantation, particularly if the foot has been stabilized by triple arthrodesis after the method of Hoke or of Dunn.

On the whole, Mr. McMurray's experience has enabled him to contribute a very readable and practical textbook on the subject of orthopaedic surgery.

DIAGNOSIS, COURSE, AND END RESULTS OF TUBERCULOUS SPONDYLITIS. Prof. S. W. Kofman. Tashkent, Committee of Sciences of the U. S. S. R., 1937.

This book, by a well-known Russian orthopaedic surgeon, presents valuable data, the result of observation for the past thirty years, and is based on material specifically studied within the period between 1924 and 1932 at the Odessa Tuberculous Institute. Three hundred and three cases thoroughly analyzed and followed up, including a great variety of pathological material, form the basis of the book. The discussion of symptomatology and treatment in the course of the development of the tuberculous disease of the spine shows an extensive experience. Prof. Kofman considers the surgical fixation of tuberculosis of the spine unsatisfactory. The best results are obtained by steady and prolonged heliotherapy combined with general treatment and fixation in appropriate apparatus. Guarded aspiration of abscesses and surgical treatment to relieve spasticity and other secondary deformities of the extremities are considered useful.

DIE VITAMINE IN DER CHIRURGIE (Vitamins in Surgery). Prof. Dr. Erich Schneider. (Vorträge aus der praktischen Chirurgie, 17. Heft.) Stuttgart, Ferdinand Enke, 1937. 3.50 marks.

This monograph deals with the leading vitamins and discusses surgical states associated with avitaminosis. Vitamin-A deficiency may be held responsible for epithelial damage in many organic systems. Its absorption from the alimentary tract is aided by the bile acids and its storage in the liver depends on an intact reticulo-endothelial system. Most animals can synthesize vitamin C from carbohydrates; only man, ape, and guinea-pig suffer from scurvy. The daily requirement of vitamin C is higher than that of the other vitamins; little of it is stored, although its highest concentration is found in the adrenal cortex. Vitamin C is essential for the production of collagen and fibroblasts; it increases circulating thrombocytes and reticulocytes and the albumin-globulin ratio and helps to activate thrombin. Vitamin D promotes fracture healing only when this is delayed by a corresponding deficiency; it seems to act locally on individual cells. Vitamin B_1 is important to the function of the alimentary tract, and as an antineuritic factor is frequently useful in sciatica and occasionally in trigeminal neuralgia; it may have a value in bone regeneration.

There is a distinct difference between the minimal daily dose necessary to prevent deficiency symptoms and that required for optimum tissue conditions; this is particularly important when one considers the sparse storage of vitamin C and the four to six months' period of deficiency diet required to precede initial gingival bleeding. A valuable table of dosage is included.

Secondary hypovitaminosis is an invariable concomitant of inflammation. The loss of vitamin C is the most important; it results in poor tissue consistency and delayed wound healing. This deficiency is to be combated by the daily parenteral administration of 300 milligrams of ascorbic acid, usually requiring ten days to produce saturation. The marked loss of vitamin A in infections may further a terminal pneumonia. Vitamin A is necessary to an adequate function of the reticulo-endothelial system. Its deficiency is indicated by the presence of cornified epithelium in a corneal smear. Vitamins A and C definitely promote antibody formation, B_1 and D perhaps only indirectly. There is no danger of overdosage of vitamins A and C. Hypovitaminosis is frequently found in the presence of an apparently adequate diet.

The tissue friability found in cancer patients is an expression of vitamin-C deficiency.

Thyroid activity favors the effectiveness of vitamins. On the other hand, thyrotoxicosis diminishes the liver storage of glycogen, fat, and fatty acids, resisting a characteristic vitamin-A effect.

An immediate effect of surgical operations is to be found in the transient abnormal excretion of vitamin C induced by general anaesthesia. Deficient liver function following operation is often the result of vitamin-A loss. Preoperative parenteral administration of vitamin A increases liver glycogen and strengthens reticulo-endothelial activity;

vitamin C improves connective-tissue function, decreases capillary permeability, and supplies part of the cellular-energy requirement.

Body growth depletes the stores of vitamins A and D and increases the demand upon vitamin C. During body growth, defects in bone formation and development result from insufficient vitamins D and C. The florid stage of all the so-called osteochondritides shows a vitamin-A deficiency. Regression of these changes follows administration of sufficient vitamin A. Paget's osteodystrophia deformans is always accompanied by a vitamin-A deficiency; Recklinghausen's osteodystrophia fibrosa generalisata, by vitamin-C deficiency.

THE RÔLE OF CHEMIOTAXIS IN BONE GROWTH. A. P. Bertwistle, M.B., Ch.B., F.R.C.S. (Edin.). London, Henry Kimpton, 1937. 8 shillings, 6 pence.

In this monograph the author, whose admirable "Descriptive Atlas of Radiographs" is familiar to students of osteology, discusses the chief theories of ectopic bone formation. Under the caption of "disruptive chemiotaxis", he describes the process whereby certain hard substances, including bone, attract and draw into themselves certain soft, living structures, such as plant roots and connective tissue. On this basis, he explains the invasion of calcified material by young blood vessels and the relationship between calcification and ossification in normal bone, and accounts for the periosteal regeneration of bone after fractures and bone grafts. As a result of this discussion, he postulates the law that wherever a calcium deposit is in contact with young connective tissue, particularly young blood vessels, bone develops. The work is illustrated with thirty-two beautiful engravings and supported by a bibliography of seventy-five references.

Our impression is that in disruptive chemiotaxis the author has described a process which is new in its application to medicine, and which goes far to explain not only normal bone growth and repair, but phenomena hitherto misunderstood in bone pathology.

SCHMERZEN UND LEISTUNGSSTÖRUNGEN BEI ERKRANKUNGEN DER WIRBELSÄULE (Pain and Functional Disturbances in Affections of the Spine). Eduard Güntz. (Beilageheft zur Zeitschrift für Orthopädie. Bd. 67.) Stuttgart, Ferdinand Enke, 1937. 15.20 marks.

This monograph deals with the spine from the clinical standpoint as a living, kinetic structure, and in its relation to upright posture. It is based on affections which are regarded as having their primary seat in the intervertebral disc. Only secondary changes in the vertebral bodies permit recognition of these conditions during life. Such affections of the intervertebral discs do not in themselves cause pain. Pain arises through resulting disturbance of mobility or stability of the spine and represents abnormal demand on muscles and tendons. Many injuries of effort are due less to the effort than to preexisting functional or structural deficiency of the spine.

A practical, careful method of physical examination is discussed; difficulties in roentgenographic examination are enumerated; and many improvements in technique are described.

Güntz, a former pupil of Schmorl, accepts Schmorl's "cartilage-node" theory to explain the pathogenesis of juvenile kyphosis. The clinical description of this condition is good.

Emphasis is placed on the need of thinking of posterior prolapse of the nucleus pulposus in cases in which symptoms are referable to the sciatic nerve or to the lower spinal cord.

Tearing of the annulus lamellosus with anterolateral escape of portions of the intervertebral disc is accorded its due place in the genesis of spondylosis deformans (hypertrophic osteo-arthritis). In occasional cases of spondylosis of the cervical and fifth lumbar intervertebral discs, narrowing of the corresponding intervertebral foramina may result.

Osteochondrosis begins with yielding of the wall of the nuclear cavity and continues with degeneration, desiccation, and loss of height and elasticity of the disc, with extrusion and chondrification of disc tissue and even posterior displacement of a vertebral body. It is of frequent occurrence, usually related to trauma, and almost always accompanied by pain and stiffness in the distribution of the lower thoracic and lumbar spinal nerves.

The proper differentiation of senile kyphosis is especially important in legal medicine. A kyphotic posture over years results in the disintegration of the anterior portions of the intervertebral discs. This leads to stiffening of the spine and even to ossification between the anterior rims of the vertebral bodies.

L'ENCHEVILLEMENT CENTRAL DES FRACTURES DIAPHYSAIRES (Central Pegging of Diaphyseal Fractures). Paul-Louis Chigot. Paris, Masson et Cie, 1937. 25 francs.

Central pegging or intramedullary bone grafting was one of the first procedures used for osteosynthesis. However, following the introduction of osteosynthesis by means of metallic plates, intramedullary grafting gradually lost favor, because of technical difficulties and the fear of biological injury to the host. With the object of throwing some light on this subject, the author experimented with different types of intramedullary grafts. Without any effort to evaluate the osteogenetic value of such grafts, he concluded that:

1. Intramedullary grafts do not interfere with the vitality of the host.
2. They lead only to a transitory fibrosis of the medulla.
3. Callus forms well and os purum, described by Svante Orell, seems to be especially well adapted to this procedure.

Considerable space is devoted to the details of technique. In general, it is the author's opinion that the method should be employed in irreducible transverse fractures of the shaft of the humerus, the femur, the clavicle, the metacarpals, and both bones of the arm and the leg.

The monograph affords interesting information and will repay reading. Its value would undoubtedly be enhanced by a study of the osteogenetic value of these grafts. Unfortunately, this problem is purposely omitted. While the results in the author's hands are satisfactory, comparative statistics on the healing of similar fractures by other methods are not given. The question of pseudarthrosis and the value of the intramedullary graft in the treatment of this condition are not mentioned.

FRACTURES AND DISLOCATIONS FOR PRACTITIONERS. Edwin O. Geckeler, M.D. Baltimore, William Wood & Co., 1937. $4.00.

The attempt to condense into 250 pages the available information on fractures and dislocations without the omission of important details is a Herculean and an almost impossible task. The author has succeeded in giving an admirable bird's-eye view of the subject, but one wishes that he had not confined his treatment to such narrow limits. For example, fractures of the skull occupy twelve and one-half lines and at the conclusion of the eleventh line is this statement: "All cranial injuries are serious and their need of competent attention cannot be over-emphasized."

The illustrations throughout the book are excellent, and adequate references to articles and books are listed at the end of each division of the subject.

On the whole, this guide is sane and safe, and the reader is left with the feeling that he would like to visit the author's clinic and discuss many matters in regard to the treatment of fractures. A book of this kind is of more value to a practitioner who is mature than to a student who has yet to cover all the ground and then choose his policy and determine his detail.

ATLAS OF SKELETAL MATURATION. T. Wingate Todd, M.B., Ch.B., Manc.; F.R.C.S., Eng. St. Louis, The C. V. Mosby Company, 1937. $7.50.

In this unusual study the author has given under the term "maturation" the results

of extensive research on the development and growth of bone. He first states his conception of the significance of the term, its relation to the general growth and size of the individual, the disturbing influences in normal growth, etc. In the introductory portion of the book he discusses the subject in general, the establishment of standards, and the plan of investigation or study by which these results were obtained.

Part I, which concludes this first volume, is devoted to studies on the hand and the standards which cover the period of from three months to the age of sixteen years in girls and nineteen in boys, at which time the symbols or determinators of maturity cease to register the progress of this process. Observations at different periods of growth have been recorded, and a distinct series is given for boys and for girls so that a comparison between the two can be made. Each observation is illustrated by excellent roentgenograms, and the maturity determinators are listed with each. This comprises the description of the essential features of the bones in the hand as shown in the x-ray, with the special appearances which are presented by this means. In this way the changes can be followed and compared throughout the period of growth.

This work is in accord with the more advanced and accurate knowledge which the perfection and the accurate use of this laboratory equipment has allowed, and indicates the marked advance of this now necessary means of diagnosis. The lack of exact knowledge of normal standards has been a handicap in many cases requiring accurate study and fine differentiation. This book eliminates much of this lack in this special field.

SURGICAL DISEASES OF THE MOUTH AND JAWS. Earl Calvin Padgett, B.S., M.D., F.A.C.S. Philadelphia, W. B. Saunders Co., 1938. $10.00.

It does not seem possible that there can be as many diseases of the mouth and jaws as the author discusses in this very elaborate book. This textbook has been prepared for the dentist, the physician, and the oral surgeon, as well as dental and medical students. All of the subjects outlined by the Curriculum Committee of the American Association of Dental Schools in 1935 have been thoroughly covered.

A review of the anatomy in relation to examination and treatment is a great help in the chapters that follow. Several chapters are given up to injuries of the bony framework and particularly to fractures. The author discusses the underlying principles of the mechanism of fractures, the aids in diagnosis, the relationship of the teeth, care of the teeth, methods of reduction and fixation of the fractures, anaesthesia, and methods of feeding. A full chapter is accorded to dislocations of the jaw.

In order to review the book completely, it would be necessary to abstract all the chapters. Suffice it to say that neurological aspects, plastic surgery, benign and malignant tumors, the principles of irradiation for malignant tumors, the technique of operative treatment of neoplasms, the repair of congenital deformities such as cleft palate and harelip, and the surgical restoration of deformities are very completely discussed. The pathological changes are emphasized.

THE PHYSICIAN'S BUSINESS. PRACTICAL AND ECONOMIC ASPECTS OF MEDICINE. George D. Wolf, M.D. Foreword by Harold Rypins, A.B., M.D., F.A.C.P. Philadelphia, J. B. Lippincott Company, 1938. $5.00.

Like Dr. Hugh Cabot's "The Doctor's Bill", this book deals with the practical and economic aspects of medicine. In a series of chapters, the author discusses such matters as the choice of hospital internship, medical careers other than private practice, specialization, location, professional contacts, records, fees, office planning, equipment, personnel, prescribing, selection and care of instruments, forensic medicine, income tax, and professional insurance. Dr. Harold Rypins, in his admirable preface, points out how essential such practical details are in the pursuit of professional success. The book is illustrated with fifty-eight simple, but graphic, figures.

This book offers tangible correctives to the liability of many good physicians to be poor men of business, and combats the fallacy that good business is beneath the dignity

of the medical profession. We heartily commend it to the perusal and practical application of those who would succeed in medicine as fully as their professional attainments qualify them to do.

EIN BEITRAG ZUR BEHANDLUNG DER FRACTURA OSSIS NAVICULARIS CARPI (The Treatment of Fracture of the Carpal Navicular). Oscar Aleman. *Acta Chirurgica Scandinavica*, LXXX, 217, 1937.

Chiefly as the result of the work of Böhler and Schnek, the recognized treatment of fresh navicular fractures consists in prolonged immobilization. Total or partial extirpation of the fragments is to be deprecated. In frank non-unions the writer suggests removal of the smaller or the distal (when of equal size) fragment. Total excision is a mutilating procedure.

The writer's series comprises ninety-one cases over a twenty-year period with a follow-up in 94.5 per cent. The end results are analyzed in detail. Three were impacted fractures; nine were "marginal", as he calls those of the tuberosity; and seventy-nine were transverse or intra-articular.

In thirty-one fresh transverse fractures there were good results following cast fixation in 74 per cent. Extirpation of one fragment in twenty-four of the cases of non-union gave good results in 83 per cent. and fair results in 17 per cent.

In six cases of non-union the fragments were drilled and then immobilized in plaster for from six to twelve weeks; the results in these cases were all bad.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ON SECONDARY EPIPHYSEAL NECROSIS AFTER COLLUM FEMORIS FRACTURE IN YOUNG PERSONS. REPORT OF 2 CASES. Asger Naeraa. *Acta Chirurgica Scandinavica*, LXXX, 238, 1937.

Two original cases and fifteen from the literature are presented in a study of epiphyseal necrosis following fracture of the neck of the femur in young individuals. According to zur Verth, one-third of these fractures result in a deformity indistinguishable from coxa plana, occurring most commonly between the ages of fourteen and sixteen, but occasionally between eleven and seventeen. In contrast to older patients, in this age group fractures of the trochanter are particularly liable to lead to deformity. A review of the literature with regard to etiology leads the writer to conclude that the necrosis is due to tearing of the synovial capsule of the neck with injury of the blood vessels to the head. Later in life, a localized necrosis is more likely from such an impaired blood supply. Freedom from weight-bearing should be maintained while the process is active, and frequent reexamination is urged for at least a year after healing.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ÜBER DIE ENTWICKLUNG DES TUBERKULÖSEN PROZESSES UND DIE ENTSTEHUNG VERSCHIEDENER AUSHEILUNGSFORMEN BEI TUBERKULOSE DER WIRBELKÖRPER SOWIE EINIGE DAMIT ZUSAMMENHÄNGENDE VERHÄLTNISSE (The Development of the Tuberculous Process and the Occurrence of Different Types of Healing in Tuberculosis of the Vertebral Bodies). Arvid Hellstadius. *Acta Orthopaedica Scandinavica*, VIII, 1, 1937.

Previous classifications of vertebral tuberculosis are first reviewed. After a study of 614 cases over a four-year period, the writer discusses the material under nine headings. The work is actually a monograph of 180 pages, with excellent x-ray reproductions, tables, and charts.

The mechanism of localization of the process and its development in various parts of the vertebral body are outlined. The occasional increase in density about a tuberculous focus is not due in most cases to compression of the trabeculae or to caseation. This perifocal increase in calcium seems to be a response to toxins elaborated by the

tubercle bacillus. Extension of a tuberculous process over intervertebral discs and subperiosteally along the bodies to cause extensive destruction without multiple implantation may be followed in serial roentgenograms. Even isolated central involvement may occur by posterior subperiosteal extension with invasion through the vascular channels. This may occur as a secondary process in a succession of bodies with definite calcification of the tuberculous tissue indicating the course.

With reference to healing, the following lesions are distinguished:

A. Paradiscal
   1. Circumscribed lesion in contact with the disc.
   2. Involvement of the entire contiguous surface.
B. Spondylitis visible only as a diminution of the intervertebral disc.
C. Extensive destruction.
D. Central spondylitis.
E. Vesicular spondylitis.
F. Anterior, posterior, and lateral spondylitis.
G. Spondylitis with diffuse osteoplastic changes.

Distribution of these types of lesions is charted for various age groups and for different levels of the spine. In cases of multiple involvement with lesions of the D, E, and F types, there was a tendency to reduplication of the same type of lesion.

Paradiscal lesions and healing by bridge formation are relatively infrequent in the first ten years of life. Healing by block formation is no less frequent under the age of ten. Spastic paralysis, associated with extensive destruction, often occurs in this age group.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

MYALGIA EPIDEMICA IM KINDESALTER (Epidemic Myalgia in Children). Gustaf Lindberg. *Acta Paediatrica*, XIX, 1, 1937.

Lindberg reviews the previous reports of epidemic myalgia in Sweden and records his own observations of an epidemic of myalgia in the fall of 1934, in which eighty children were attacked. Most of the cases occurred during the month of September. The incidence was greatest at the age of seven. Seventy patients were under twelve years of age. Pain appeared without prodromes except slight malaise, usually in the chest or abdomen, occasionally in the neck or arms. The pain was severe in character. In twenty-five cases there was swelling of the musculature. In a number of the patients intrathoracic or intra-abdominal lesions were suspected. In most instances there was a mild leukopenia, in a few a leukocytosis of 12,000. The blood-sedimentation rate was followed in twenty-three patients. In these a mild increase in the blood-sedimentation rate was observed during the course of the disease. A meningitis with increased pressure of the spinal fluid, positive Pandy test, and increased cellular content were noticed in five cases. All of these patients recovered promptly. The duration of symptoms was usually four or five days. No microscopic examination of the muscles was made, nor could the author find any record of any pathological study in the literature. The author believes that the disease is an acute infectious process which spreads much like influenza. The only treatment was symptomatic. All of the patients recovered completely.—*John G. Kuhns, M.D., Boston, Massachusetts.*

BEITRAG ZUR KENNTNIS DER "PERITENDINITIS CALCAREA" (SOGEN. "BURSITIS CALCULOSA") SPEZIELL VOM PATHOLOGISCH-HISTOLOGISCHEN GESICHTSPUNKT. [A Contribution to the Knowledge of Peritendinitis Calcaria (So-Called "Bursitis Calculosa") from the Histopathological Viewpoint.] Carl Sandström und Fredrik Wahlgren. *Acta Radiologica*, XVIII, 263, 1937.

The roentgenographic, operative, and pathological studies of twelve cases of peritendinitis calcaria, involving the shoulder, the hip, the knee, and the ankle, are reported. Calcium deposits were found in the tendons, the capsule, and the periosteum.

Microscopically the deposition of calcium seemed to be secondary to necrosis or necrobiotic lesions. Since the arterial branches showed thickening of the media or narrowing of the lumina, the authors regard the necrosis as being due to vascular disturbance. Morphologically the picture is one of chronic inflammation.

The etiology is discussed, but no positive statement is made on this point.—*A. R. Smith, M.D., Iowa City, Iowa.*

LIFE EXPECTANCY AND INCIDENCE OF MALIGNANT DISEASE. V. MALIGNANT LYMPHOMA, FIBROSARCOMA, MALIGNANT MELANOMA, AND OSTEOGENIC SARCOMA. Ira T. Nathanson and Claude E. Welch. *The American Journal of Cancer*, XXXI, 598, 1937.

This is the fifth in a series of papers by these authors dealing with the life expectancy and incidence of malignant disease of various regions. The authors have analyzed the material available at the Huntington Memorial Hospital and Pondville Hospital, including 161 cases of fibrosarcoma and eighty-one cases of osteogenic sarcoma. Graphs are presented showing the life expectancy of patients with these diseases as compared with the normal life expectancy of the age group. Statistical studies have been made of the age and sex incidence. The median age of the fibrosarcoma group was forty-one years, that for the osteogenic-sarcoma group was twenty-five years. The median life expectancy after onset was forty-three months in fibrosarcoma and twenty-one months in osteogenic sarcoma. Five years after onset death has occurred in 58 per cent. of the fibrosarcoma cases and in 85 per cent. of the cases of osteogenic sarcoma.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

OSTEITIS DEFORMANS (PAGET'S DISEASE). FISSURE FRACTURES—THEIR ETIOLOGY AND CLINICAL SIGNIFICANCE. M. Lowry Allen and Rutherford L. John. *The American Journal of Roentgenology and Radium Therapy*, XXXVIII, 109, 1937.

The authors believe that roentgenologists and surgeons in general are quite unfamiliar with the entity of these fissure fractures in Paget's disease, as well as their clinical significance. They state that the literature contains little on this condition and that there is a lack of observation of such cases over a prolonged period.

It is the authors' opinion that fissure fractures occurring in Paget's disease are due to slight trauma; hence, they may be regarded as incomplete pathological fractures. The authors believe that such fractures are responsible for the lengthening of the involved bone. These fractures generally heal with minimum amount of callus formation, which assumes the characteristics of the dominant Paget's disease. However, with slight trauma, they may go on to complete fracture which is characteristically transverse.

Four cases are described in which typical Paget's disease was present and fissure fractures in the cortex of the convex surface of the bone appeared. In two of the cases these fissures became complete transverse fractures, due to local trauma. Union occurred in both cases.—*R. M. Wray, M.D., Iowa City, Iowa.*

IDIOPATHIC FAMILIAL GENERALIZED OSTEOPHYTOSIS. Ernst Freund. *The American Journal of Roentgenology and Radium Therapy*, XXXIX, 216, Feb. 1938.

The author states that the case which he describes, aside from its unusual individual manifestations involving gigantic deformities of the extremities, has great importance from a theoretical viewpoint. It represents a condition which, at first, entails difficulties of differentiation,—whether it be an aborted form of acromegaly, or a hypertrophic osteo-arthropathy, or whether it is altogether in a class by itself.

The patient was a man, fifty-seven years old, who, at the age of fourteen, following an attack of measles, had begun to show swelling and tenderness in the fingers. The con-

dition had progressed steadily and extensively, apparently with periods of exacerbation. Often in the springtime the manifestations recurred and the hands and feet became enlarged to the proportions of gigantism. The condition gradually increased until it resulted in the patient's relinquishing his vocation of farming. It affected different parts of the body, and the enlargement was prodigious, particularly below the knees. Also affected at times were the ligamentous structures.

The author gives a very thorough description of the changes and distribution in this case, which evidently was one of extreme degree and allowed opportunity for thorough study.

The question of classification of this case is discussed thoroughly and the author refers especially to the normal state of the intrathoracic viscera observed clinically and roentgenographically, and to the long duration of the malady, affording opportunity for the development of the periosteal bone production found. He rules out the ordinary case of Bamberger-Marie osteo-arthropathy, but considers the fact that there are a number of cases wherein hypertrophic osteo-arthropathies give no evidence of any metapneumopathic cause and others in which the bone changes are not associated with arthritis. The author is inclined to accept Crump's suggestion that the term "*ostéoarthropathie hypertrophiante pneumonique*" (Marie) be omitted, and that the term "generalized osteophytosis" be substituted. Under this heading he classifies the case which he describes. He mentions the lack of familial occurrence in this case, but believes it to be a point of only relative significance, since the patient had only half-brothers on his mother's side and knew nothing of his father. He feels that this point of the family history is of interest in dealing with a constitutional disease, the disposition to which is transmitted by the father alone, the children of the mother by another man being normal.—*Percy Brown, M.D., Boston, Massachusetts.*

Osteomyelitis in Children. Frank R. Ober. *American Journal of Surgery*, XXXIX, 319, Feb. 1938.

The etiology, pathology, bacteriology, and roentgenographic appearance of the different types of osteomyelitis are discussed, and the management of each type is given.

Acute osteomyelitis is a different problem in children under two years of age, probably due to differences in the character of the bone. The streptococcus is the predominating organism. Sequestrum formation is rare. In acute osteomyelitis in children over two years of age, the staphylococcus is the predominant organism. Sequestrum formation is the rule. In acute cases without severe constitutional symptoms, the local process is an emergency problem. However, the desperately ill child in poor physical condition is treated systemically until his condition permits simple drainage. A marked reduction in mortality has been obtained by following this rule.

Chronic osteomyelitis is divided into three groups: (1) sclerosing osteomyelitis; (2) Brodie's abscess; (3) chronic osteomyelitis following the acute type. The author suggests a non-weight-bearing splint for any case of chronic active osteomyelitis of the lower extremity.

Infrequent dressing of wounds in all types is recommended. The skin wound must be kept open as widely as possible until the cavity in the bone is well filled with firm, granulating tissue. Early skin healing favors retention of discharging products, delaying bone healing.—*O. Anderson Engh, M.D., Washington, D. C.*

Fractures and Dislocations Involving the Elbow Joint in Children. D. E. Robertson. *American Journal of Surgery*, XXXIX, 327, Feb. 1938.

Fractures of the elbow region are classified into those involving: (1) the supracondyle; (2) the lateral condyle; (3) the mesial epicondyle; (4) the olecranon; (5) the head and neck of the radius; and (6) the ulna (in its proximal half) with dislocation of the head of the radius. The diagnosis and special treatment for each type are given. Careful

examination of the arm for interference with function of nerves or blood vessels is stressed to prevent malpractice suits. Closed reduction should be accomplished as soon as possible after the accident. In the presence of shock, gross deformity should be diminished. Open operation is often necessary to fix the fragments in accurate position. The use of screws or fine dowels of boiled beef bone is recommended for fixation. The need of close observance of the limb distal to the fracture for two days following reduction is stressed. Morphine should not be administered following a reduction without first ascertaining complete blood supply and normal motion of the hand and fingers. Proper roentgenograms and perfect reduction in fractures involving articular surfaces are important.—*O. Anderson Engh, M.D., Washington, D. C.*

COMPOUND FRACTURES IN CHILDHOOD. Fenwick Beekman. *American Journal of Surgery*, XXXIX, 312, Feb. 1938.

The author stresses the importance of conservative judgment. Hasty decisions of a radical nature may result in the loss of a limb or even in the death of the patient. Injuries in children offer more chance for eventual improvement than in adults. Deformities and poor function benefit by age and adaptation. Reconstruction operations some years later may return the part almost to normal. Amputation, unless absolutely necessary, is advised against.

The automobile has produced compound injuries from without in contrast to the compounding from within, which was formerly the case. Efficient splinting, prevention of further contamination, and early traction are recommended. The importance of adequate cleansing is stressed. Satisfactory reduction at the first attempt is necessary, for manipulation at a later date diffuses infection. Infrequent dressing of wounds and early immobilization are advocated. The fractures and wounds of severe crushing injuries are best treated by traction and suspension, immobilizing the part, restoring alignment and length to the bone, and obliterating dead spaces by stretching and pulling muscles into their original position. Early skin grafts lessen scar tissue and contracture. —*O. Anderson Engh, M.D., Washington, D. C.*

PRIMARY BONE TUMORS IN CHILDREN. Bradley L. Coley and Richard L. Peterson. *American Journal of Surgery*, XXXIX, 334, Feb. 1938.

Early recognition of primary bone tumors in children lies in the field of paediatrics and of orthopaedic surgery. Primary malignant tumors of bone are most frequently observed in children and in young adults. This is especially true of Ewing's sarcoma and osteogenic sarcoma. The tendency to consider the symptoms as rheumatic or neuritic is an obstacle to early diagnosis. The failure to take roentgenograms early is also responsible for error in diagnosis. Pain, in the absence of signs of infection, should arouse suspicion. The location of a tumor is a valuable guide in determining the type. The services of a well-trained roentgenologist are indispensable for arriving at a diagnosis and assisting in treatment. The pathologist is also an invaluable member. The importance of phosphatase, calcium, and phosphorous determinations and of the aspiration biopsy is mentioned. Irradiation, resection, amputation, and the use of Coley's mixed toxins in the treatment of the various bone tumors are discussed. Irradiation and surgery in the same case are inadvisable. It is hoped that the advances in diagnosis of malignant bone lesions, made in the last two decades, will be duplicated by advances in treatment.—*O. Anderson Engh, M.D., Washington, D. C.*

RELATION BETWEEN TUBERCULIN ALLERGY AND CLINICAL COURSE. J. M. Appel, B. H. Douglas, T. R. Jocz, and H. S. Willis. *The American Review of Tuberculosis*, XXXVI, 303, 1937.

Tuberculin sensitiveness fluctuates, but not closely in accord with changes in the patient's clinical condition. From the evidence at hand it would seem that no definite

conclusions can be drawn between tuberculin sensitiveness and the clinical course. Therefore, the degree of reaction to the tuberculin test is no indication of the amount of clinical disease.—*Clarence A. Ryan, M.D., Vancouver, B. C., Canada.*

A New Administrative Technique in Tuberculosis Case-Finding. Bruce H. Douglas and Henry F. Vaughn. *The American Review of Tuberculosis*, XXXVI, 325, 1937.

This is a brief presentation of the plan now being initiated in Detroit and Wayne County for the detection of tuberculosis. The basis of this plan is the general practitioner who is paid by the Health Department the sum of one dollar for tuberculin testing, and one dollar for the final consultation of positive reactors. Where x-rays are necessary (that is in all positive reactors) the private x-ray laboratory may undertake such work at a fee of three dollars, or the patient may be referred to the Health Department for such examination. Follow-up work is under the Department of Health, but any diagnosis or advice to the patient is given by the general practitioner after consultation with the Department of Health staff. This removes any possibility of the patient's being "scared" by being informed of his diagnosis by someone with whom he has not had any former contact. While the experience under this plan has been of very short duration, it indicates that the plan offers great promise of success in finding cases early.—*Clarence A. Ryan, M.D., Vancouver, B. C. Canada.*

La artrorrisis posterior del pie (Posterior Arthroereisis of the Foot). Oscar R. Marottoli. *Anales de Cirugia*, III, 84, 1937.

The special technique which the author advocates is based upon the insertion of a free graft as described by Camera. A U-shaped incision is made in the retromalleolar region, extending from the inferior portion of the metaphysis of the tibia and the malleolus toward the external border of the foot in the direction of the cuboid. The tendons of the peronei are separated and retracted to one side, and the tendo achillis and the flexor hallucis longus are exposed. An arthrotomy, exposing the articular surface of the astragalus, is then performed.

From the external surface of the external malleolus a bone graft—four centimeters long, one and one-half centimeters wide, and about one centimeter thick—is recovered. The foot is then placed in the necessary position of dorsiflexion, so that the posterior portion of the cartilaginous surface of the astragalar body comes into view. A cuneiform trough is made and in this bed the peroneal graft is inserted with light taps of a hammer. This graft extends out for a distance of one or two centimeters in order to form a buttress against the posterior tibial surface. The author believes that it is preferable to insert a large graft in the oblique, upward, and forward direction, so that it may become better solidified with the substance of the astragalus.

The foot is immobilized in the position of correction in a plaster cast. In cases of flexion contracture, the lengthening of the tendo achillis precedes the insertion of the bone graft. *A. Steindler, M.D., Iowa City, Iowa.*

Rupture of the Supraspinatus Tendon. T. Wallis Davis and John E. Sullivan. *Annals of Surgery*, CVI, 1059, 1937.

During 1936 the authors saw five cases of complete rupture of the supraspinatus tendon, all within seventeen days following injury. They discuss briefly the anatomical relations of the muscle and call attention to the fact that rupture of the tendon usually occurs in men past middle life. All of their cases occurred in the sixth decade of life. These patients were all muscular men who had performed hard manual labor for many years, which bears out the theory that age and occupation produce pathological changes in the tendon that predispose it to rupture.

In four cases operated on within two weeks of the injury the tendon was ruptured immediately proximal to its insertion. In three of these there was blood-tinged joint fluid in the subacromial bursa.

Codman lists eighteen conditions which are associated with complete rupture. Two of the authors' cases examined within twenty-four hours presented all of these conditions,—namely, hard manual labor; over forty years of age; no symptoms prior to the accident; adequate injury, usually a fall; immediate sharp brief pain; severe pain the following night; loss of power of elevation of the arm; negative roentgenogram; little, if any, restriction when stooping; faulty scapulohumeral rhythm,—a tender point, a sulcus, and an eminence at the insertion of the supraspinatus, which causes a jog, a wince, and soft crepitus as the tuberosity disappears under the acromium when the arm is elevated and usually, also, as it reappears during descent of the arm. In the authors' cases pain was the most variable symptom.

In the authors' five cases the tendon was sutured to the greater tuberosity by means of drill holes, and the ends of the tendon were sewed together with silk sutures. The authors believe that suture of the tendon is the only form of treatment, and that it should be carried out immediately. In their four cases operated on within thirteen days there was very little retraction of the tendon. The postoperative treatment consisted of immobilization in abduction and external rotation for two or three weeks.—*O. B. Bolibaugh, M.D., San Francisco, California.*

INTERNAL FIXATION FOR RECENT FRACTURES OF THE NECK OF THE FEMUR. Melvin S. Henderson. *Annals of Surgery*, CVII, 132, Jan. 1938.

In a rather complete review of the subject, the author states that experience at The Mayo Clinic has showed that the risk of operative treatment is no greater than that of conservative treatment, provided operation is performed ten days or longer after injury.

Operative treatment promises a better chance for a good result than conservative treatment.

The author applies traction to the extremity immediately after the injury as preliminary treatment before operation. Pain is controlled by traction and by administration of opiates.

The operative treatment eliminates the need of prolonged confinement in a plaster spica and obviates the sequelae of stiff knees and hips.

The author reviews the various methods of internal fixation, the development of the cannulated nail and lag screw, and points out the technical difficulties of the operation and the importance of roentgenographic control with anteroposterior and lateral views. He describes in considerable detail the lag screw developed at The Mayo Clinic and compares its relative merits with the Smith-Petersen nail.

Fourteen days after the operation, motion of the hip and knee can be safely started. This is carried out by means of an overhead suspension apparatus which can be operated by the patient. Union cannot be expected under ninety days. Weight-bearing must be delayed for at least six months.

Henderson next discusses the results in fourteen cases operated on more than a year ago in which the condition of the patients is known. Bony union and excellent function were obtained in 86 per cent. of the cases. No serious infection occurred. Drainage followed late in two cases. There were no deaths from operation, and convalescence was much more satisfactory than by the conservative method.—*O. B. Bolibaugh, M.D., San Francisco, California.*

TEARS OF THE SUPRASPINATUS TENDON. RÉSUMÉ OF TWELVE OPERATED CASES. Tom A. Outland and Walter F. Shepherd. *Annals of Surgery*, CVII, 116, Jan. 1938.

Since 1934 the authors have seen fourteen cases and have operated on twelve, at which time the lesion was demonstrated and the tendon was repaired. Between 1928

and 1934 they diagnosed only three such cases, which now leads them to believe that they failed to recognize the condition.

Rupture of the supraspinatus tendon is due to trauma, either from a fall with the arm suddenly abducted to break the fall or by direct blow (or fall) on the back of the shoulder. Predisposing causes are age and an existing pathological condition of the tendon.

Rupture takes place at or near the greater tuberosity. There is frequently associated a tear in the floor of the bursa, producing a direct communication with the joint.

The authors emphasize the following points in diagnosis:

1. Diminution or loss of the power of abduction.
2. Tenderness over the greater tuberosity.
3. Undue prominence of the greater tuberosity.
4. Crepitus of a fine nature over the tuberosity as it moves under the acromion on passive movement of the arm.

The authors advocate suture of the tendon unless the tear is very small, in which case rest in abduction is indicated.

In the recent cases, the tendon is sutured with two or three heavy mattress sutures. In the older cases, scar tissue is excised from the edges of the tendon before suturing. When there is insufficient tendon attached to the tuberosity, the proximal end of the tendon is anchored in a groove in the tuberosity by means of silk sutures passed through drill holes.

The postoperative treatment consists of immobilization by use of an axillary pad, sling, and bandage. When the wound is healed, sinusoidal current and "bending" exercises are given. At the end of three weeks, assisted active and other exercises are started.

Of the twelve patients operated upon, the results were excellent in four, good in four, fair in three, and poor in one.—*O. B. Bolibaugh, M.D., San Francisco, California.*

RATIONALE OF BONE DRILLING IN DELAYED AND UNUNITED FRACTURES. Proviso V. Prewitt and E. R. Easton. *Annals of Surgery*, CVII, 303, Feb. 1938.

In discussing the subject of osteogenesis in fracture repair, following the drilling operation, the authors evaluate the following aspects: (1) skeletal maturity; (2) effect of local environmental biophysical states upon bone production; (3) normal bone, a balanced physiological mechanism; and (4) possible physiological effects from the drilling operation.

The authors report fourteen cases of delayed union or non-union that were successfully treated by this method.

The drilling operation is indicated in cases in which: (1) one of the opposing fragments is viable; (2) there is potentially adequate arterial blood supply in one of the fragments; (3) the distance between the fragments is not too great to be spanned by a reasonable amount of new bone.

The authors conclude that bone regeneration following the drilling operation results from enrichment of the local circulation, stimulation of bone cells along the drill canals to renewed activity, and the elaboration of calcium and phosphorus conjugating enzymes necessary in the formation of bony callus.—*O. B. Bolibaugh, M.D., San Francisco, California.*

PRODUCTION OF OSTEOSARCOMA IN A MOUSE BY THE INTRAMEDULLARY INJECTION OF 1, 2-BENZPYRENE. A. Brunschwig and A. D. Bissell. *Archives of Surgery*, XXXVI, 53, Jan. 1938.

Brunschwig and Bissell report the experimental production of bone-forming sarcomata in rats following the intramedullary introduction of carcinogenic chemicals. They believe that this is the first instance of the experimental production of an osteosarcoma by a chemical agent. The chemicals used were 1, 2-benzpyrene and cholesterol.—*I. William Nachlas, M.D., Baltimore, Maryland.*

THE NICOLA OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER. Harry Koster. *Archives of Surgery*, XXXVI, 61, Jan. 1938.

In a rather short but clear article Koster describes the Nicola operation for recurrent dislocation of the shoulder. He emphasizes the importance of firm fixation of the tendon in the tunnel through which it is passed. He also stresses the desirability of the Z-shaped incision to the small transverse section of the tendon. Three cases are reported.—*I. William Nachlas, M.D., Baltimore, Maryland.*

SPEICHENBRÜCHE DES ERWACHSENEN AN TYPISCHER STELLE (Fractures of the Radius at Typical Sites). Hans Kotrnetz und Fritz Geiringer. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVII, 504, 1937.

Since 1928, at Denks Clinic in Vienna, a total of 873 cases of radial fractures at the wrist have been treated by the Böhler method of reposition under local anaesthesia and fixation in unpadded plaster casts. Certain modifications are practised,—notably delayed reduction of most fractures. Unless marked displacement is present, the fracture is kept splinted for at least twenty-four hours before reduction is performed. According to the authors, the delay permits swelling to reach a maximum before the cast is applied.

At the time of local anaesthesia through the dorsum (the hematoma remains fluid) an additional infiltration of the ulnar-styloid region is performed.

Reduction by traction without violence is practised, attempts at anatomical reposition being stressed. A circular cast is applied.

Circulatory disturbances are carefully watched for. (In one of two early cases in which the casts were not split promptly, an ulnar palsy developed, which remained permanently.) In eighty-five cases the plaster had to be split. The cast is left on from three to five weeks, union and painless function in the cast comprising the indications for its removal. Non-union of the ulnar styloid occurred in 152 of 248 cases. Dorsal subluxation of the ulna was observed in twenty-six and volar subluxation in nine of the cases reexamined. The authors agree with others that longer fixation in a long arm plaster is indicated, but are skeptical about 100-per-cent. results.

Good cosmetic and functional results were obtained, if there existed no tendency to axial shifting. When a tendency to shortening of the radius appeared, good function, but a worse cosmetic result, was obtained. While ideal anatomical reposition is aimed at, it is not an absolute necessity for a good functional result. On the contrary, excellent repositions (in the roentgenogram) were not always associated with corresponding function.

Attempts at reposition after eight to fourteen days delay healing about two weeks, and tend to increase circulatory disturbances.

Seven types of fractures about the wrist are listed. The patients with severe intra-articular fractures were well in general in twelve weeks, while those with transverse fractures were well in from seven to nine weeks.—*J. E. Milgram, M.D., New York, N. Y.*

ÜBER DIE PSEUDARTHROSE DES OS NAVICULARE MANUS (Concerning Pseudarthrosis of the Carpal Navicular). I. Boerema. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 42, 1937.

The author reports a group of thirty-six fractures. Six of these were old and in each case the ulnar fragment had been removed more than ten years previously. About half of the remainder, early cases, had been treated by mobilizing methods. The other half, recent cases, were treated by immobilization in ulnar adduction according to Böhler.

Of seventeen patients with pseudarthroses, who were reexamined, fifteen had limitation of volar and, especially, of dorsal flexion up to 50 per cent. of that of the normal hand. Two had a normal range. Seven of the patients were obliged, because of pain on use, to seek a less arduous occupation. Two patients, despite pseudarthroses, suffered in no way, as far as work was concerned. Limitation of motion bore no relation to disability. In short, objective signs were no measure for subjective complaints.

The author takes issue with Böhler's absolutely favorable prognosis in this fracture (100-per-cent. union reported in 150 fresh cases). However, he is in favor of this type of treatment.

He reports five cases of spontaneous union without treatment of any sort, and shows the roentgenograms in each case. Three of these were cases of incomplete fracture.

Of the six patients in whom the ulnar fragment had been removed prior to development of arthritic changes, all but one were able to resume full use of the hand, a matter of much surprise to the examiner.—*J. E. Milgram, M.D., New York, N. Y.*

NERVENSCHÄDIGUNGEN DURCH INTRAMUSKULÄRE INJEKTIONEN (Nerve Injuries through Intramuscular Injections). H. Demme. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 205, 1937.

Aside from the general toxic effect of injected protoplasmic poisons, local nerve lesions resulting from intramuscular injections are not very rare. Such extremity palsies, especially of the radial nerve, have been repeatedly reported. The author observed the appearance of paralysis of the extensor indicis proprius following a quinine injection into the extensor aspect of the forearm. For this reason, intramuscular injections had best be confined to the glutei and, indeed, as the old rule states, only to the upper outer quadrants of the glutei.

The author reports five cases of injury to the sciatic nerve after intragluteal injections. The drug was quinine in three cases, chlorcalcium in two cases. Motor (mainly peroneal), sensory, and occasionally trophic changes, usually permanent, followed. Characteristic was the appearance of severe pain as the immediate sequela of the injection. In one case the material passed up the sciatic-nerve sheath to the spinal ganglia. Animal injections corroborate the possibility of this occurrence.—*J. E. Milgram, M.D., New York, N. Y.*

ZUR PATHOLOGIE UND BEHANDLUNG DER PERONEUSSEHNENLUXATION (Pathology and Treatment of Dislocated Peroneal Tendons). Joh. Volkmann. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 262, 1937.

The author refutes the common concept of a widened sheath with a subluxated tendon lying anterior to its normal groove. In his experience, the tendon sheath is torn as is the upper restraining band. The anterior origin of the sheath is also torn loose, often with a roentgenographically demonstrable fragment of bone, leaving the bone of the groove bare.

Through an adequate incision, the author replaces tendon and sheath into the grooves, fastening the sheath with two or three sutures passed through drill holes if necessary. The anterior flap of the tendon sheath is brought over the posterior and fastened for reenforcement. The restraining bands need not be reconstructed.

Three cases in working men have been operated upon successfully. The longest postoperative period is three years.—*J. E. Milgram, M.D., New York, N. Y.*

ARTHROPLASTY IN THE LOWER EXTREMITY. Samuel Kleinberg. *Archives of Surgery*, XXXIV, 1072, 1937.

The object of this operation is the establishment of useful motion in ankylosed joints or the increase of existing motion. It is not probable that 100-per-cent. motion will be obtained. Cases of traumatic origin are the most favorable; those with rheumatoid arthritis, eburnation of bone, or fibrosis of the muscles are the most unfavorable. The patient must desire the operation, and should be between twenty and forty-five years of age, in good general condition, free of infection, and not too stout. His social and financial position must also be considered.

The principles governing the procedure are as follows: (1) Enough bone should be removed to ensure easy motion; (2) the articular surfaces should be smooth and well

fitting; (3) the capsule should not be stripped too much; (4) the operation should not be performed on a limb that is greatly deformed; (5) there must be good circulation about the joint; (6) the function of the muscles should be good.

The principle feature of the technique of arthroplasty is the interposition of material to prevent contact, preferably a double layer of autogenous fascia lata or a pedicle flap of muscle, fat and fascia, chromicized pig bladder or ox fascia. Trauma should be avoided as much as possible. Hemorrhage may be controlled by an Esmarch bandage and hemostasis. For the incision at the hip, the half U or anterior Smith-Petersen incision should be used. It is important to have a capacious acetabulum and a snugly fitting capsule. At the knee, the incisions recommended are: the bilateral (Baer), the curved lateral (Campbell), the inverted Y (Putti), or the median-patellar (Kleinberg). Postoperative care is most important. Immobilization should be maintained for a minimum of two weeks. To obtain traction, a spica is applied with the limb flexed and the hip in 10 degrees of flexion and 25 degrees of abduction. At the end of the second or third week, the spica is removed and the limb is placed in a balanced swinging apparatus (a Thomas splint or plaster posterior shell).—*E. F. Case, M.D., Iowa City, Iowa.*

La trazione scheletrica agli arti inferiori nelle complicanze paralitiche delle fratture e lussazioni vertebrali (Skeletal Traction on Lower Extremities in Paralytic Complications of Vertebral Fractures and Dislocations). Antonio Poli. *Archivio di Ortopedia*, LIII, 79, 1937.

Poli describes the method of treatment of lesions of the vertebral spine with involvement of the spinal cord as he observed it at Böhler's Clinic. To prevent decubital ulcers on sacrum and heels, or to treat such ulcers more easily once they have developed, both lower extremities are placed on Braun's splints, and skeletal traction is applied through the tibial tubercles. The patient is able to raise himself with the arms, which facilitates the bathing of the patient and the making of the bed. Physical therapy is more easily applied.—*Ernst Freund, M.D., Los Angeles, California.*

Lussazione congenita dell'anca (Congenital Dislocation of the Hip Joint). Antonio Poli. *Archivio di Ortopedia*, LIII, 3, 1937.

The author has presented a statistical study from the *Pio Istituto dei Rachitici di Milano*, based on 8,610 cases observed from 1903 to 1936, including 12,105 deformities, the richest material ever investigated in one clinic.

Congenital dislocation of the hip joint is more frequently found in the female (84.36 per cent.) than in the male (14.64 per cent.). The dislocation is more frequently unilateral (60.89 per cent.) than bilateral (39.11 per cent.). The left side is more often affected (16.98 per cent.) than the right (13.91 per cent.). Bilateral dislocation occurs more often in the female (39.87 per cent.) than in the male (35.03 per cent.). Unilateral dislocation is more frequent in males (64.97 per cent.) than in females (60.13 per cent.). Congenital subluxation is more common in the female than in the male. Subluxation is more often unilateral (97.39 per cent.) than bilateral (2.61 per cent.). The condition was hereditary in 7.57 per cent. of the cases. Paternal transmission is more frequent (1.72 per cent.) than maternal (1.36 per cent.). The deformity was familial in 18.75 per cent. The deformity was noticed in 7,064 cases when the child started to walk (89.51 per cent.); in 493 cases at the time of birth or within the first months of life (6.31 per cent.); in 320 cases during the first year of life (4.06 per cent.). The ages of the patients at the time of admission were from one to three years in 5,419 cases (64.30 per cent.); in 1,881 cases, from three to six years (22.81 per cent.); in 569 cases, from six to ten years (6.87 per cent.). The average age of the patients decreased during the period from 1934 to 1936 to twenty months, as compared with four years during the period from 1903 to 1905.

Treatment consisted of the reduction manoeuver of Paci-Lorenz in 7,561 cases, open reduction in thirty-four cases, palliative surgical treatment in 360 cases, and bloodless palliative procedures in 519 cases.

The late results were good in about 52 per cent. of the cases. In unilateral cases with an observation time of under five years the results were good in 71.82 per cent.; in bilateral cases good results were obtained in only 40.26 per cent. With an observation period of more than five years, the results in unilateral cases were good in 61.16 per cent., in bilateral cases, in 38.85 per cent. In the treatment of patients during the first year of life, results obtained by simple immobilization in abduction were excellent in 92 per cent. Results by open reduction were good in only 20 per cent. of the cases when treated after the age of five, in 32 per cent. when treated younger.—*Ernst Freund, M.D., Los Angeles, California.*

SULLA COSIDETTA EPICONDILITE OMERALE (The So-Called Epicondylitis of the Humerus). A. Mastromarino. *Archivio di Ortopedia*, LIII, 133, 1937.

The author has studied three cases of his own and the quite extensive bibliography on the subject. He mentions all the different factors which have been considered of etiological importance and feels very sure that muscles play the only significant part. Anatomical and functional investigations revealed that it is the common extensor of the fingers which is responsible for the pain. There are certain anatomical peculiarities around the insertion of this muscle or the epicondyle, which, together with an unusual structure of the dense muscle fascia, lead to a critical functional stage. Morphological variations of the skeleton may aid in bringing about a painful condition of the elbow. The muscle undergoes pathological changes under the influence of prolonged forceful action, either by faulty mechanics of the muscle or by impaired circulation which changes the biochemistry of the muscle tissue. Histological specimens removed from two cases were entirely negative for alterations of the periosteum or of the bone. There were changes in the muscle tissue in the sense of a chronic inflammatory process.

As far as treatment is concerned, the author is in full agreement with Hohmann and strongly recommends surgical intervention. He does not believe that conservative treatment can give lasting results.—*Ernst Freund, M.D., Los Angeles, California.*

SULLA LUSSAZIONE ABITUALE DI SPALLA (Habitual Dislocation of the Shoulder). Aldo Fiorentini. *Archivio di Ortopedia*, LIII, 171, 1937.

After a complete review of the clinical picture, etiology, pathological anatomy, pathogenesis, and treatment of habitual dislocation of the shoulder, eight cases are reported in which the operation of Cattaneo was performed. The results were uniformly excellent. The technique consists in a suspension of the head of the humerus with fascia lata. The strip of fascia is passed below the neck of the humerus, and the ends are united tightly over the acromion. A plaster-of-Paris cast is applied in abduction.—*Ernst Freund, M.D., Los Angeles, California.*

LA TRAPANAZIONE OSSEA NEL TRATTAMENTO DEL MORBO DI PERTHES (Bone Drilling in the Treatment of Perthes' Disease). Antonio Poli. *Archivio di Ortopedia*, LIII, 215, 1937.

On a basis of five cases, the author demonstrates that multiple drilling of the epiphyseal line is of beneficial influence on the clinical course of Perthes' disease. The duration of the disease is shortened and repair is hastened.—*Ernst Freund, M.D., Los Angeles, California.*

LA FRATTURA PARCELLARE DELL'EPIFISI SUPERIORE ESTERNA DELLA TIBIA (Chip Fracture of the Upper Outer Epiphysis of the Tibia). Lodovico Armani. *Archivio di Ortopedia*, LIII, 241, 1937.

Three cases of chip fractures at the upper outer epiphysis of the tibia are described. They occurred during strenuous gymnastic exercise. The author thinks that sportsmen

may have stronger ligaments than normal, especially between the fibula and the tibia, and these fibers may be responsible for the lesion. Roentgenographic examination is absolutely necessary in any knee-joint lesion, because such small fractures may remain unrecognized clinically and lead to the erroneous diagnosis of sprain. The treatment consists in the application of an elastic bandage.—*Ernst Freund, M.D., Los Angeles, California.*

LA FRACTURA DEL CUELLO FEMORAL DEL ANCIANO (Fracture of the Neck of the Femur in the Aged). Herman De Las Casas. *Boletin de los Hospitales*, XXXV, 591, 1937.

The author classifies fractures of the neck of the femur as "internal" and "external" fractures. The point of division is where the internal vessels (from the capsular ligament and synovia) reach the neck of the femur, about one centimeter from the edge of the head. This classification has a physiological basis, because, in the internal fractures, the head of the femur, without enough blood supply, becomes necrosed.

The treatment varies according to the general condition of the patient.

In the case of an internal fracture, if the patient is a poor risk, extirpation of the fractured head is done, without any other procedure. If the patient is a good risk, a subtrochanteric osteotomy is also done. The upper fragment is placed in adduction and the lower one in abduction, the result being an angle on the external surface. By this procedure, the shortening of the femur and the insufficiency of the gluteal muscles are corrected.

In the case of an external fracture, if the patient is a poor risk, an osteosynthesis is done, using a Sven Johansson nail. If the patient is a good risk, a bone graft, taken from the tibia, is used instead of a nail. With a special instrument, a cylindrical form is given to the graft.

When only the extirpation of the head of the femur is done, the result is claudication, because of the shortening of the femur and insufficiency of the gluteal muscles. With the other operations, the functional result is good. The author considers the bone graft better than the nail because he has found a good deal of rarefaction of the bone in contact with the nail. — *Abraham Schwartz, M.D., Santiago, Chile.*

THE SUPERVENTION OF OSTEOGENIC SARCOMA IN PAGET'S DISEASE. T. B. Davie and W. E. Cooke. *The British Journal of Surgery*, XXV, 299, 1937.

"Two cases are described of multicentric foci of osteogenic sarcoma arising in patients suffering from Paget's disease (osteitis deformans). The features of this 'Paget's sarcoma' are discussed in the light of information obtainable from a review of the literature. The features particularly studied are: the aetiological relationship of sarcoma to the coincident Paget's disease; the sex and age incidence; the time factor in the development of the sarcoma; the sites of election of the sarcoma; the multicentricity of foci in these growths; the microscopical features; coincident changes in other organs and tissues; views as to the aetiology of Paget's disease; the nature of the initiating stimulus resulting in sarcomatous change; prognosis and treatment.

"The conclusions drawn from these considerations are that Paget's disease predisposes affected bones to sarcomatous changes, and that this malignant supervention arises at sites of stress in those bones showing advanced changes of osteitis deformans, possibly as the result of the stimulus of a super-added endocrine disturbance."

TWO CASES OF DIAPHYSIAL ACLASIS SHOWING SARCOMATOUS CHANGE. E. K. Gardner. *The British Journal of Surgery*, XXV, 323, 1937.

Diaphyseal aclasis is the name given to a hereditary condition exhibiting multiple exostoses. Keith has stated that he believes this to be due to an arrest of periosteal extension at the ends of the diaphysis. It must be distinguished from dyschondroplasia which is characterized by the presence of masses of endosteal cartilage in the metaphyseal regions.

The writer cites two cases of malignant changes,—namely, the formation of a locally malignant cartilaginous neoplasm in such a process. Both cases showed a sudden increase in size in a known exostosis. Radical operation is indicated.

FRACTURES OF THE SHAFT OF THE FEMUR. A NEW METHOD OF TRACTION AND IMMOBILIZATION. Eric L. Farquharson. *The British Journal of Surgery*, XXV, 592, Jan. 1938.

A Kirschner wire is passed through the lower end of the femur. A portable traction table with a screw traction device is used. Reduction is accomplished with both the hip and the knee flexed. A tensometer spring is included in the line of pull to measure the amount of pull being used, which may be as high as ninety pounds before reduction is obtained.

After reduction, a full-length unpadded plaster casing, in some instances with the addition of a spica, is applied with the traction still in effect. After the plaster is dry, the pull is reduced to fifteen or twenty pounds in the line of the femur. By an ingenious use of loops made in the plaster, the leg is suspended over an overhead pulley. Traction is maintained for four or five weeks.

INTERLOCKED ARTICULAR PROCESSES COMPLICATING FRACTURE-DISLOCATION OF THE SPINE. A SURVEY OF SOME RECENT CASES TREATED BY OPEN OPERATION. Alan H. G. Munro. *The British Journal of Surgery*, XXV, 621, Jan. 1938.

Three cases of fracture-dislocation of the spine with paraplegia are cited. In all of these there was transposition of the intact articular processes. Reduction by manipulation is impossible in this type of case, and manipulation may do harm to the already damaged cord.

Early open operation is advised. In order to aid in manipulation through the open wound, spats attached to a rope and pulley-block are secured to the patient's feet. At open operation, it is easy to reduce the fracture. Improvement is reported in two cases, and there was no change in one.

FRACTURED LUMBAR SPINE WITH UNILATERAL DISLOCATION. A. Wilfrid Adams. *The British Journal of Surgery*, XXV, 632, Jan. 1938.

A boy of seventeen was injured by falling under a bus. Roentgenograms showed a deformity of the fourth lumbar vertebra, with a displacement of the spine forward and with angulation in the anteroposterior view. There were also fractures of the first four right transverse processes.

Closed manipulation was unsatisfactory and open operation was done four days later. The spinous processes of the third and fourth lumbar vertebrae were fractured. The superior articular facet of the fifth lumbar vertebra was bare on the right side, while the inferior articular process of the fourth had jumped over it and was deep to it. The lamina of this vertebra lay obliquely astride the upper edge of the fifth. By hyperextending the pelvis on the spine and by using a bone lever, the displacement was corrected. Recovery was complete.

FRACTURE OF THE OS CALCIS. W. J. Eastwood. *The British Journal of Surgery*, XXV, 636, Jan. 1938.

Forty-seven cases, with a total of fifty-three fractures, are reviewed. Forty-seven fractures were treated by simple immobilization with preservation of the arch by plaster, but with no attempt to restore the normal alignment. Eighty per cent. of the patients

returned to their old occupations, and very few complained of any discomfort. A few patients were treated by arthrodesis and two by Böhler's skeletal traction. The results were not as good as in those cases treated by the simpler method.

The writer doubts that the usual causes for poor results—spur formation, loss of the arch, excessive bone below the external malleolus, etc.—are really factors at all. He believes that the arthritis of the subastragalar joint is the common cause of poor results.

He believes that the simpler treatment is the best and advocates non-interference. Freedom from weight-bearing for three months with the foot in plaster, followed by active use with massage and assisted movements, and manipulation under anaesthesia two or three months later, is the course advocated. He quotes one insurance company executive as regretting treatment for this condition by an orthopaedic surgeon but advocating the simpler treatment by the patient's own doctor.

TREATMENT OF SPASTIC PARALYSIS. F. H. Mills. *British Medical Journal*, II, 414, 1937.

The treatment outlined by the author was developed more than twenty years ago during the War in the course of work done on soldiers convalescing from cerebrospinal meningitis. Since that time, only the more severe spastic cases have been treated,—for example, those suffering from cerebral diplegia or Little's disease and, more recently, the spastic cases resulting from post-thrombotic paralyses.

In discussing the various etiological factors, the author emphasizes that many of the patients when first seen appear to be idiots. After treatment only four patients have had to be rejected as true idiots.

The author particularly stresses the pronounced degree of associated sensory disturbance in these patients. It is manifested in various ways such as loss of appreciation of relative intensity of different stimuli, or of appreciation of spatial relationship, and interference with the interpretation of proprioceptive impulses, especially in the smaller joints, is often noted. All the phenomena of incoordination are for the most part of sensory origin, and educative therapy must also have a sensory basis. Therefore, treatment resolves itself into inhibition of the motor spasm followed by an intensive sensory and, to a lesser extent, motor education. Motor education must follow the sensory.

Inhibition of muscle spasm is the first essential in treatment. This is initially accomplished by use of the warm bath (37 degrees centigrade) to promote relaxation of the spastic muscles, and at the same time these affected muscles are gently manipulated. Muscle groups are treated proximodistally in succession until they relax. Such stimuli cause a state of inhibition of the spasm and what is termed the "inhibitory after-period" develops, which, in turn, is gradually extended as treatment proceeds and generally becomes permanent,—that is, conditioned. As found in Pavlov's experiments, the inhibition will readily spread,—for example, if the muscles of the face are inhibited, dribbling of saliva will cease and often incontinence of bladder and rectum will be controlled. At no time are rhythmic movements or quick cyclic movements attempted.

Deformities yield to stretching by special apparatus once inhibition of muscle spasm has been effected. Stretching should never exceed half an hour each day and should not cause pain. In only three of the 370 cases was tenotomy required. Ramisectomy now has no part in the treatment of spastic paralysis; in fact, in the author's experience, it is often harmful. Likewise, it is believed that Stoffel's operation is contra-indicated, as following this procedure the paralyzed parts of the muscle later become fibrosed and retract and spasticity returns.

The author stresses the fact that the cases treated along the lines described have been of the most severe type of spasticity. The treatment obviously requires energy, enthusiasm, and the maintenance of a cheerful outlook.—*G. E. Haggart, M.D., Boston, Massachusetts.*

TUMORS OF BONE. RESPONSIBILITIES OF THE PATHOLOGIST. J. S. Young. *British Medical Journal*, II, 647, 1937.

The author advocates that, following every amputation of a limb for bone tumor or while performing every post-mortem examination in which a deep-seated or inaccessible bone tumor is present, the pathologist should bisect the bone containing the lesion at right angles to the plane of the best roentgenogram available, or in such other plane as will best facilitate the interpretation of the roentgenogram. After determination of the histological structure and classification of the growth, then the roentgenologist and the pathologist, together with the surgeon, should correlate the macroscopic and microscopic appearance of the growth with the roentgenogram. The preparation of giant sections of the whole tumor or segment thereof is likewise particularly stressed for the purpose of correlating roentgenology with pathology.

A detailed discussion regarding the advisability of biopsy is given, with the conclusion that an open biopsy is not lethal; in fact, the author believes that, in view of Wood's experiment on rat sarcoma and rat carcinoma, an open biopsy may not even be dangerous. The method of Hoffman—that is, puncture of the bone sarcoma by a wide-bore needle attached to a twenty-cubic-centimeter syringe—is definitely condemned.

The article concludes with the following suggestions:

1. In every surgically accessible and radio-apparent bone lesion which might conceivably be bone sarcoma, decompression by open operation should be carried out as soon as possible.

2. At this operation a piece of tissue, large enough to be considered a fair sample of the lesion, should be excised for microscopic examination. This process should be repeated if the pathological report is not conclusive.

3. If the lesion is proved to be a bone sarcoma, amputation or wide resection should be carried out immediately, or, if the lesion is not a bone sarcoma, other appropriate measures should be instituted.—*G. E. Haggart, M.D., Boston, Massachusetts.*

ZUR KLINIK UND PATHOLOGIE DER SYNOVIOME (Clinical and Pathological Aspects of Synovioma). A. Fehr. *Bruns' Beiträge zur klinischen Chirurgie*, CLXV, 88, 1937.

The author adds four more cases of synovial sarcoma to the seventeen previously reported in the literature. Photographs and histological sections are well reproduced.

The author stresses the slow but sure malignancy of the lesion. He emphasizes the difficulty often encountered in the pathological identification of the synovial origin. Clefts in the tissue early in tumor history usually enable recognition of the tissue of origin. Late sections may reveal purely sarcomatous structure.

In early cases, where feasible, he advises wide excision with the diathermy knife. If this cannot be accomplished with certainty, or if the lesion has recurred, amputation must be performed.

When metastasis occurs, the lungs are most often involved. The regional lymph nodes are next often the site of tumor involvement.—*J. E. Milgram, M.D., New York, N. Y.*

BEITRAG ZUR KENNTNIS DER PRIMÄREN MUSKELTUBERKULOSE (A Contribution to the Knowledge of Primary Muscle Tuberculosis). Shunro Kushizaki und Kunio Saito. *Bruns' Beiträge zur klinischen Chirurgie*, CLXV, 177, 1937.

The authors report two cases,—one in a male, twenty-four years old, and the other in a female, thirty-four years old. In the first case, the lesion was solitary, involving the pectoralis major. In the second case, there were multiple lesions, and almost symmetrical masses were present in the four extremities. This case also presented calcified hilus nodes.

These masses are difficult to diagnose clinically, since they move with the muscle, and they are smooth and usually tender. The overlying skin is not involved. Radical excision is advised.

The authors list the varieties of pathological changes reported in the literature as nodular, abscess type, and fungoid-sclerosing. Half of the cases reported were of the abscess type. The multiple-lesion type, seen by the authors, showed fungoid-sclerosing lesions and is most rare.

Pathological identification usually is essential to diagnosis, since the masses grossly resemble tumors, parasitic infestation, and chronic specific inflammatory lesions.

The more recent literature is carefully analyzed, and colored plates of the operative findings in their two cases are reproduced.—*J. E. Milgram, M.D., New York, N. Y.*

ENDSCHICKSALE VON KRANKEN MIT GELENKNAHEN TUBERKULÖSEN KNOCHENHERDEN UND GROSSEN TUBERKULÖSEN SEQUESTERN (End Results in Cases of Tuberculous Osseous Foci near Joints and with Large Tuberculous Sequestra). H. Nase. *Bruns' Beiträge zur klinischen Chirurgie*, CLXV, 572, 1937.

An analysis of thirty-three cases treated conservatively and thirty-three cases treated by surgical excision enables the author to draw indications for treatment. From one-half to two-thirds of all tuberculous lesions rupture from a bony focus into the neighboring joint. The surgeon's problem is to minimize this joint involvement. These cases were followed for varying periods ranging from five to fifteen years. Small numbers of cases appear in each group. In general, conservative therapy, when successful, obtained healing in an average of fifteen months. In 45 per cent., fistulae or abscesses developed. Of seventeen cases of lesions of the long bones, treated by surgical extirpation of the focus, twelve healed. The average time of healing in the surgically treated cases was seven months.

In general, the local tuberculous lesions, if in the short bones of the extremities, or if inaccessible to surgery, or if epiphyseal damage threatens in children, had best be treated conservatively. Conservative therapy is also advised in dubious cases in the upper extremity, since strain from weight-bearing does not exist here.

Operative therapy is advised for patients of all ages if the lesions are in the long bones in the neighborhood of the larger joints. Local excision of the focus helps the general resistance in cases where generalized infection exists.—*J. E. Milgram, M.D., New York, N. Y.*

ZUR BEHANDLUNG DER TRAUMATISCHEN SYMPHYSENRUPTUR (Treatment of Traumatic Rupture of the Symphysis). Gustav Sommer. *Bruns' Beiträge zur klinischen Chirurgie*, CLXV, 607, 1937.

Four cases of symphysial separation treated by pelvic compression (two in a sling, one operatively, and the fourth in a sling supported by an overhead frame) are reported. The author finds that the displacement is readily corrected conservatively. Good results were obtained in three cases. One patient died of a massive pulmonary embolus two months after injury. Post-mortem examination revealed thrombosis of the left femoral vein at the level of Poupart's ligament as the cause of the embolism. The symphysis in this case was one centimeter wide and filled with fibrous tissue. The original diastasis had amounted to six centimeters.

In the one case operated upon, wire fixation was employed. Suppuration developed, necessitating removal of the wire. The patient walked three months after injury with less than one centimeter of residual separation.

In one case hematuria persisted for several days, but with spontaneous micturition, indicating an injury to the pars membranacea or a mild bladder injury.—*J. E. Milgram, M.D., New York, N. Y.*

RÉFLEXIONS À PROPOS DE LA RÉSECTION DE LA HANCHE (Resection of the Hip). Jean Verbrugge. *Bulletin de la Société Belge d'Orthopédie*, IX, 115, 1937.

The author advocates resection of the hip in cases of painful deformation of the hip as in those of arthritis deformans. He is convinced that the pain is due to the lesion of the

hip joint itself, not to muscle spasm. The subcapital fracture is the only one for which there is as yet no definitely satisfactory method of treatment; at the present time Whitman's plastic reconstruction is the only method which affords an opportunity for healing, but it is difficult and involves the risk of pseudarthrosis.

The femoral head should never be resected without liberation of the gluteus medius and lowering of the greater trochanter upon the femur. The resection of the hip should never be attempted without careful exposure, and the head should never be sectioned until the hip has been dislocated out of the cotyloid cavity.

An incision is made at the greater trochanter from the anterior superior spine, in the furrow between the anterior border of the gluteus medius and posterior border of the tensor fascia, extending downward to the interior aspect of the greater trochanter and across to the external surface of the femur. The femoral aponeurosis is then carefully incised in the same line between the two muscles; the muscles are separated downward to the base of the greater trochanter and upward one or two centimeters above the anterior superior spine. The loose tissue which covers the articular capsule is then directly exposed. The deep fibers of the gluteus medius can easily be resected by inserting the spatula under the muscle and outlining the greater trochanter. The latter is sectioned at its base or somewhat lower and isolated at its posterior aspect from the pelvic trochanteric muscles. The surgeon then works upward to the acetabular cavity, exposing the neck and head at the cotyloid rim. It will be found that the ankylosis is never complete, and, with the help of a large spoon, one is able to penetrate into the acetabulum, the entire surface of which can be uncovered by the cutting of the round ligament, with the limb in adduction, flexion, and forced external rotation. It is then possible, by a few taps with the chisel, to liberate the head from the neck at its base. The borders of the neck are then rounded off, and the neck is replaced.

For the lowering of the greater trochanter, the limb is placed in forced abduction, if the gluteus medius has been well liberated at its lower extremity and the greater trochanter has been sectioned low enough. The upper end of the vastus externus is then sectioned longitudinally, the upper surface is exposed and freshened, and the greater trochanter is nailed in its new position by a long, boiled-bone nail inserted obliquely from below upward for the entire thickness of the femur. There is no drainage, and a plaster-of-Paris cast is applied.

Recently, the author has placed the patient in bed without a cast and has simply immobilized the limb in strong abduction with sand bags. After eight days, passive mobilization is begun, followed by active mobilization in three weeks. The patient sits up during the fourth week, remains up after five weeks, and is permitted to walk after the sixth week.

The author has treated fifteen cases by this method and has obtained good results in all. The pain has definitely disappeared; the patients have begun to walk at the end of the second month; and the shortening has varied between three and five centimeters. The mobility depends upon the deformation of the cotyloid cavity; it is always about 25 per cent. less than normal.—*Arthur Steindler, M.D., Iowa City, Iowa.*

PATHOGÉNIE ET TRAITEMENT DU GENOU EN FLEXION (Report on the Pathogenesis and Treatment of Flexion Contracture of the Knee). M. Soeur et L. Ronse. *Bulletin de la Société Belge d'Orthopédie*, IX, 176, 1937.

Scars, due to burns, infections, aponeurotic lacerations, tendon injuries, metastatic abscesses, tuberculous fistulae, congenital intra-uterine ulcerations, and ankylosis following purulent processes, arthritis, or osteomyelitis, are etiological factors. The authors also discuss extra-articular and intra-articular blocks due to habitual luxation of the patella, semilunar dislocations, condylar lesions, meniscus cysts, joint mice, tears of the cruciate ligaments, synovial fringes, chondromatosis, exostoses, and flexion following juxta-epiphyseal osteomyelitis and gonorrhoeal arthritis. In the chronic arthritides, retraction of the posterior capsule and synovial adhesions play an important rôle. Con-

tractures resulting from diseases of the nervous system, myositis, dystrophies, myatonia, myopathies, the development of the long bones and their muscles, and the mechanical theories of the development of congenital malformations are considered. In discussing contractures of nervous origin, the traumatic, neoplastic, and inflammatory lesions of the peripheral nerves are described, together with amputation neuromata and neuralgias, and contractures due to periarticular irritation. The contribution to these contractures by the central nervous system is then explained, as, for example, in the hemiplegias and other spastic lesions, Pott's disease, intradural tumors, vertebral fractures, hematomyelia, syringomyelia, and multiple sclerosis. A large number of cases are due to Little's disease and certain lower motor-neuron lesions of poliomyelitis. Finally, the authors consider contractures due to functional or hysterical causes.

Then follows a review of the general physiopathology of knee contractures based on the mechanics of the joint, the influence of weight, pull on the cruciate ligaments, the capsule, the lateral ligaments, and the ligamenta alaria. In the matter of pure mechanics, due weight is given to the resolution of muscle forces, angles of application, leverage, and the play of agonist and antagonist groups. In the clinical physiopathology, the symptoms of contracture of the individual muscles are considered, as well as the influence of a pathological flexion contracture of the hip upon the knee. The mechanics of weight-bearing upon a contracted knee is fully discussed.

The final section deals with treatment. The optimum position is that of ankylosis of from 10 to 15 degrees. Treatment consists of prophylaxis in infectious cases, correction of subluxation of the tibia by splints, and physiotherapy after the acute stage. In the period of convalescence from poliomyelitis, electrotherapy and heat are advocated. In the spastic cases, muscle training is of the greatest importance. Tuberculous contracture in children yields to continued extension.—*Arthur Steindler, M.D., Iowa City, Iowa.*

USE DESTRUCTION IN THE HUMAN BODY. A. W. Meyer. *California and Western Medicine*, XLVII, 375, 1937.

The author describes in considerable detail the traumatic conditions, resulting from use or motion between two or more surfaces, found in the dissection room. These injuries are of mechanical origin and are classified under thirteen groupings:

1. Superficial and deep synovial bursae. These may be frayed or partially destroyed, without increase of the bursal content.

2. Fraying of articular capsules. The fraying of articular capsules of the knee and of radiocarpal articulations suggests the origin of some of the classic synovial villi.

3. Articular-capsule defects. These defects, large and small, may be present in the shoulder, in the acromioclavicular and hip joints, and in some eleven or twelve other locations.

4. Destruction of ligaments. It is obvious that the glenohumeral, coracohumeral, and femoral round ligaments must be divided during the formation of large defects.

5. Muscle fraying. Muscles sometimes fray when in contact with each other or with other structures.

6. Tendons. Tendons may be frayed on one or both sides. Those most commonly frayed are the tendon of the supraspinatus and that of the long head of the biceps.

7. Dislocation of tendons. Ventral dislocation of the tendon of the long head of the biceps is the most frequent tendon dislocation.

8. Destruction of fibrocartilages. The articular fibrocartilages show fraying, especially the inner margins of the glenoid and genual cartilages.

9. Destruction of hyaline articular cartilages. The hyaline articular cartilages begin disintegrating at the surfaces and this proceeds inward to the bone.

10. Fissuring of the intervertebral discs. The intervertebral discs often are fissured horizontally, seen most often in those spinal areas subject to the greatest motion, and in the latter decades of life.

11. Erosion of bone. When bone erodes through the cortical layer beneath the articular cartilage, the underlying spongiosa becomes sclerosed.

12. Rupture of tendons. Tendons were found ruptured only after attrition and weakening.

13. Formation of bony excrescences. These result from periosteal irritation and may accompany bone denudation.

The author has found no evidence of *restitutio ad integrum*, and he believes that marked destruction can slowly proceed without severe pain or awareness of injury.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

OSTEOMYELITIS OF THE SUPERIOR MAXILLA IN NEW-BORN INFANTS. A. Goldbloom and H. L. Bacal. *The Canadian Medical Association Journal*, XXXVII, 443, 1937.

This condition presents a strikingly uniform clinical picture of fever, swelling of the cheek and eyelids on the affected side, suppuration pointing both on the cheek and inside the mouth, unilateral nasal discharge, augmented by pressure on the cheek, and finally sequestration of one or all surfaces of the maxilla, with loss of deciduous teeth and permanent tooth buds, and often deformity of the affected side of the face. "It is now generally believed that cases reported in the early literature as empyema of the antrum of Highmore in new-born infants were all cases of the condition under discussion." The authors believe that the infection is often staphylococcal.—*D. E. Robertson, M.D., Toronto, Canada.*

TUBERCULOSIS OF THE SYMPHYSIS PUBIS. A. Ambros. *Chirurgja Narzadow Ruchu i Ortopedja Polska*, X, 92, 1937.

The author describes two cases of tuberculosis of the symphysis pubis in young women in whom an arthrodesing procedure would cause a serious set-back in subsequent labor. The author secured good results by sequestrectomy, excision of the foci, packing of resulting cavities with sterilized vaselin, and closure of wounds.—*Emanuel Kaplan, M.D., New York, N. Y.*

POST-TRAUMATIC OSSIFICATION OF THE OBTURATOR EXTERNUS. Z. Ambros. *Chirurgja Narzadow Ruchu i Ortopedja Polska*, X, 99, 1937.

The author reviews the classification of myositis ossificans and cites the rarity of its occurrence in the pubic insertion of the adductors. A case of gradual ossification of the obturator externus in a tennis player is described. The roentgenogram shows a gradual increase in the density of the ossified obturator. The case was observed for three years. The process produced a posterior extra-articular arthrodesis of the hip joint with considerable limitation of motion.—*Emanuel Kaplan, M.D., New York, N. Y.*

ESTADO ACTUAL DEL TRATAMIENTO DE LAS FRACTURAS DEL CUELLO DEL FÉMUR (The Present Status of the Treatment of Fractures of the Neck of the Femur). Ignacio Chavez. *Cirugiay Cirujanos*, V, 453, 1937.

The author has reviewed the diverse and more or less complicated techniques which have been devised for the treatment of the various types of fractures of the neck of the femur. He divides these into three groups: (1) immobilization by mechanical traction; (2) immobilization by plaster-of-Paris casts; and (3) retention of the fragments by surgical means with or without immobilization by mechanical traction or plaster-of-Paris casts.

The first group is represented principally by the method of Phillips which was perfected by Ruth. This method is now practically never used.

The second group comprises the Whitman method with its modification by Apfelbach and Aries, and the Jones technique. The author points out that in elderly patients from 40 to 50 per cent. of the cases treated by the Whitman method result in failure.

He states that the modification of the Whitman method by Apfelbach and Aries is not uniformly successful. He feels that the Jones method has much to recommend it, but he has as yet not been able to obtain definite statistics in regard to end results.

The third group is composed of surgical methods whose object is the maintenance of coaptation of the parts by metal screws; wood, bone, or hornlike supports; metal plates; autogenous bone grafts: the Smith-Petersen nail; and Kirschner wire. The author discusses Albee's operation with its modifications by Ortiz Tirado and Böhler, and Delbet's technique which he considers too complicated for general use. Leadbetter's technique in the reduction of fractures is considered, and the use of the Smith-Petersen nail is described in detail. The author then discusses the technique of Aries and Dyas with the modification by Moore, which is the method that he prefers. He employs the Kirschner wire as the retentive agent.

From his study of these various methods, the author draws the following conclusions:

1. Surgical treatment of fractures of the neck of the femur gives the best results.
2. During the last few years the techniques have been simplified with the tendency to avoid arthrotomy.
3. The easiest technique is that of Dyas and Aries as modified by Moore.—*Carlos Finck, M.D., Torreon, Coah., Mexico.*

Die Ausheilungsvorgänge am Wirbelbruch unter besonderer Berücksichtigung der Frage der traumatischen Spondylosis deformans; (Tierversuche). [Healing Process in Fractured Vertebrae with Special Consideration to the Question of Traumatic Spondylitis Deformans; (Animal Experimentation).] Alfons Lob. *Deutsche Zeitschrift für Chirurgie*, CCXLVIII, 452, 1937.

In a former article the author proved that there is always a localized spondylitis after isolated injury to the anterior part of the intervertebral disc. In this paper he reports on injuries of the vertebral columns in rabbits. He produced after laparatomy: (1) a fracture to one or two neighboring vertebrae alone; and (2) a fracture to a vertebra plus an injury to the intervertebral disc.

He concludes that the vertebra heals with endosteal and periosteal regeneration, mainly periosteal. The callus is always moderate in amount and is limited to the nearest vicinity of the fracture. There is never any bridging or "*randwulst*". When vertebra and disc are injured, two distinctly different healing processes take place: (1) The repair of the fractured vertebra occurs over osteoid tissue; (2) the repair of the lesion to the disc brings on an enormous proliferation of chondroid tissue which calcifies, forming spondylolytic exfoliations. This proliferation takes place only after injury to the anterior part of the disc, but not when the lateral parts are injured.—*H. D. Bruns, M.D., Iowa City, Iowa.*

Kniegelenksarkom nach Röntgenbestrahlung (Sarcoma of the Knee Joint After X-Ray Radiation). F. Becker. *Deutsche Zeitschrift für Chirurgie*, CCXLVIII, 11, 1937.

Sarcomata arising as result of the x-ray effect on tissues are very rare clinically. Fifteen cases have been assembled from the literature. The author reports one case in a female, twenty-five years old. At the age of eleven, the patient was treated by x-ray radiation for swelling of the knee, clinically diagnosed as tuberculosis. Tremendous overradiation was administered by a non-medical technician. Six months later, skin atrophy appeared together with a small swelling over the patella. This swelling soon spontaneously subsided. Six years later (1928) the tumor reappeared and grew very rapidly, soon reaching the size of a fist. In 1932 the tumor was resected. Only chronic inflammatory pathology was histologically reported. Clear, small zones of atrophy were visible in the patella and lower femur. In 1935, two months after a pregnancy, the patient returned with marked increase of local findings and an obvious sarcoma of the lower end of

the femur (chondrofibro-osteoid sarcoma on section). Metastases were present in the lung. The patient was still alive at the date of the report.

These sarcomata arise from four to eight years after irradiation. Most of the patients are young people who have been given overdoses of irradiation for tuberculosis. The prognosis is very unfavorable. Most of the cases have revealed histologically a polymorphocellular or spindle-cell sarcoma. Radiation of the epiphyseal zones may be a factor.—*J. E. Milgram, M.D., New York, N. Y.*

CALCINOSIS CUTIS WITH HETEROTOPIC BONE FORMATION. J. G. Finder. *Illinois Medical Journal*, LXXI, 219, 1937.

Little is known of the origin of this disease. Pathologically the process seems to be that of degeneration or damage to tissue, most probably the subcutaneous fat, with resulting calcification. The circulatory rôle is also considered. The changes may be interpreted as follows:

1. Necrotization and impregnation with calcium of the collagenous material.
2. Fibrous-tissue encapsulation.
3. Reorganization.
4. Metaplastic changes, so that formative bone tissue develops and matures.
5. Creeping substitution of the calcified mass and laying down of bony tissue.
6. Continued necrosis of the central elements because of difficulty of organization.

Treatment is based on improvement of circulation and local excision of the masses. One case is reported.—*Donald B. Slocum, M.D., Iowa City, Iowa.*

PATHOLOGIC FRACTURES. Ralph K. Ghormley, Charles G. Sutherland, and George A. Pollock. *Journal of the American Medical Association*, CIX, 2111, 1937.

This paper is based on a study of 600 pathological fractures. These fractures are divided into three groups: (1) fractures due to metastases from malignant lesions; (2) fractures caused by primary malignant lesions of bone; and (3) fractures due to other causes, as benign bone tumors and non-neoplastic bone diseases. No cases involving bone tuberculosis are included in the statistical analyses.

In the metastatic group most of the lesions were of the ribs and vertebrae, with no cases in which the hands or feet were affected. In a large number of cases metastasis to bone followed carcinoma of the breast (127 out of 278 cases), which was also true for hypernephroma, and carcinoma of the stomach, the latter being rarely recognized. Classed as "metastatic malignancy indeterminate", however, were cases in which metastatic bone lesions were found without discoverable primary malignancy. Many of them were believed to have been myelomata.

Osteogenic sarcoma was the most frequent of the primary malignant bone lesions. There were also a relatively large number of fractures associated with Ewing's tumor, which is indicative of the destructive nature of this tumor.

The largest group due to benign bone lesions was composed of cases of senile osteoporosis (ninety-two out of 269 patients). Schmorl has given an accurate description of the pathology. It usually occurs in patients over fifty years of age. It is important in that it is the second most frequent pathological fracture, being surpassed only by that due to metastasis from carcinoma of the breast. The next largest group of fractures resulting from benign bone pathology is comprised of cases of osteitis fibrosa cystica which, for the most part, appears as multiple lesions in shafts of long bones in children. Other causative lesions are giant-cell tumor, osteogenesis imperfecta, and osteomyelitis, in the order of frequency as listed.

Detailed charts accompany the article, which makes the information easily assimilable and should be of aid in making a differential diagnosis of any presenting pathological fracture.—*W. B. Carrell, M.D., Dallas, Texas.*

DIFFERENTIAL DIAGNOSIS OF PAIN LOW IN THE BACK. ALLOCATION OF THE SOURCE OF PAIN BY THE PROCAINE HYDROCHLORIDE METHOD. Arthur Steindler and J. V. Luck. *Journal of the American Medical Association*, CX, 106, Jan. 8, 1938.

The medical literature is incomplete and indefinite in regard to the exact pathology and the manner of occurrence of low-back pain. According to the authors, the old conceptions of lumbosacral and sacro-iliac entities appear inadequate. Many theories of causation have been advanced by investigators, but sufficient proof for acceptance has not been offered. Architectural deficiencies of the lumbar region may be the cause of low-back discomfort and instability. Most congenital anomalies, however, should be considered as predispositional and not as direct etiological factors.

The authors substitute a new vertical for the old horizontal classification of this complaint. They study the routes of the sensory-nerve supply to the tissues of the lumbosacral area. The posterior division of the spinal nerves in this locality supply many important structures, including the sacrospinalis muscles, all of the posterior ligamentous connections, and the intervertebral and sacro-iliac articulations. Irritations from localized peripheral lesions may cause superficial pressure tenderness with radiation of pain along either the posterior or the anterior spinal-nerve divisions. Postural anomalies may be the result. The frequency of radiation of low-spine pain has been estimated as being from 37 to 60 per cent.

Localization of an anterior-division lesion is fairly definite. Intraspinous pathology and extramedullary tumor give accurate indicative signs. Nerve compression within the intervertebral foramen as a cause is being accepted in place of a funicular origin. It is pointed out that many of these symptoms are not due to this form of neural pressure, but have a reflex origin by way of the "nervus sinuvertebralis" described by Purkinje and Luschka.

The posterior-division syndrome comprises the structures supplied by the posterior division of the spinal nerves. These structures act as a unit, and tension is transmitted to them in the forward-flexion test and in the stretching of the hamstrings. These signs are positive in cases of regional fibrositis and myofascitis. In the majority of cases of posterior musculo-aponeurotic or ligamentous involvement, a localized pressure tenderness is present in the sacral triangle.

The anatomical foundations of many of the tests for low-back pain are reviewed and evaluated. The authors reach the conclusion that the symptoms of local tenderness, pain radiation, and faulty posture may apply to the posterior-division as well as to the anterior-division syndrome.

Believing that in many such cases the pain radiation was reflex in nature and not due to root or cord pathology, the authors devised a test in which from five to ten cubic centimeters of 1-per cent. procaine hydrochloride is injected into the localized area of tenderness. The skin is anaesthetized, and the needle is carried down to identify the painful structures. These are then injected with the solution. Five requirements must be met for a positive result. They are:

1. Contact with the needle must aggravate the local pain.
2. Contact with the needle must elicit or aggravate radiation.
3. Procaine-hydrochloride infiltration must suppress local tenderness.
4. Procaine-hydrochloride infiltration must suppress radiation.
5. The positive leg signs must disappear.

Of the 145 patients selected and subjected to the test, 100 (69 per cent.) gave a positive response. Of the original group, conservative treatment was adequate in 103, showing the close agreement between the test and the anticipated results following treatment. Eleven other cases, surgically treated, are presented in detail.

The authors conclude that the posterior syndrome, with its localized tenderness and reflexly radiated pain, occurs in a large number of patients with low-back complaints; and the novocain injection is an accurate test for the presence of this condition.—*Alonzo J. Neufeld, M.D., Dallas, Texas.*

INJURIES OF THE KNEE JOINT. Frank D. Dickson. *Journal of the American Medical Association*, CX, 122, Jan. 8, 1938.

Derangements of the knee joint due to trauma are common. The author discusses in detail injuries to the menisci, to the internal lateral ligament, and to the cruciate ligaments.

He points out the fact that the medial meniscus is attached in its posterior half to the internal lateral ligament and that its anterior half is relatively free. Any stress upon the ligament produces a cross-strain upon the cartilage at the junction of the mobile and the immobile portions. In 214 cases of cartilage derangement he found the medial meniscus involved 3.7 times more frequently than the lateral.

The immediate cause is trauma, usually indirect. When the foot is fixed and the knee is partially flexed, inward rotation of the femur puts a direct strain upon the internal lateral ligament. The cartilage is pulled inward and is torn loose at its anterior attachment. It may be fractured or crushed between the grinding articular surfaces. The fracture usually occurs in the middle third.

Diagnosis is based upon a history of a torsion strain upon a flexed knee followed by acute synovitis, an inability to extend the knee completely, and pressure tenderness over the anterior portion of the injured cartilage. In chronic cases the symptoms vary, but, as long as the cartilage remains displaced, limitation of complete extension will persist.

Treatment depends on whether the patient has an initial or a recurring attack. In the former, complete immobilization is desired. A plaster knee cage is worn for three weeks and then weight is borne gradually with the joint protected by an elastic bandage. In recurrent cases, surgery is indicated as the cartilage is apt to be fractured.

The entire cartilage is removed if possible, although the author feels that complete removal is not absolutely necessary in every case.

Injury to the internal lateral ligament is five times more frequent than is damage to the external lateral ligament. Pressure tenderness is usually present over the femoral attachment and the knee is kept partially flexed, less stretch being put on the ligament in this position. Absolute immobilization of the joint in plaster for from four to five weeks is usually sufficient to allow the ligament to heal and to prevent, or at least to minimize, traumatic exostosis or ossification of the ligament at the site of the rupture or tear. If laxity of the joint persists, the ligament may be tightened by moving its tibial attachment downward or, preferably, by reinforcing the ligament with fascial strips.

Rupture of the cruciate ligaments, with or without fracture of the tibial spine, is caused by severe violence. The most constant sign of tibial-spine fracture is a definite bone block to full extension. As a rule, rupture of the cruciate ligaments is not difficult to diagnose. For acute injury, immobilization in plaster for from two to three months is essential. In chronic cases, surgical reconstruction of the ligaments, using fascia lata, is indicated. The results are fairly satisfactory.—*Harold M. Childress, M.D., Dallas, Texas.*

PATHOLOGIC CONDITIONS OF THE SPINE. PAINFUL DISTURBANCES OF THE INTERVERTEBRAL FORAMINA. Lee A. Hadley. *Journal of the American Medical Association*, CX, 275, Jan. 22, 1938.

The author recognizes two distinct types of pathological changes which produce thinning of intervertebral discs and constriction of the intervertebral foramina. The first, occurring in early life, is a herniation of the nucleus pulposus. The second, occurring in later life, is a fragmentation of the cartilaginous plate.

This thinning of the disc brings the vertebral bodies closer together. In the cervical and lower lumbar areas, the posterior articulations are likely to override, producing the so-called apophyseal subluxation. Because of the inclination of the plane of these articulations, subluxation may result in wedging of the lower vertebra forward beneath the one above, producing distortion and constriction of the intervertebral foramen.

In the case of a marked lordosis, some of the patient's weight may be thrust backward

onto the posterior articulations, with the production of extreme apophyseal subluxation even without thinning of the disc, while, as a result of sprain or thinning of the anterior portion of the disc, a reverse subluxation of the apophyseal joints may be visualized as a pulling apart of the articular processes.

A third cause of constriction of a foramen, particularly in the mid-cervical region, is the presence of bony exostoses projecting from the vertebral disc into the lumen.

In addition to the characteristic roentgenographic appearance, patients have pain and tenderness to deep pressure in the neck or back with restricted motion and muscle spasm. Muscle spasm tends to maintain overriding, causing a persistence of pain. Referred symptoms are those of radiculitis with the pain corresponding in distribution to that of the involved nerve root. The patient does not complain of pain on pressure along the course of the nerve, but the nerve roots are painful to deep pressure along the spine. Homolateral or contralateral scoliosis may be present.—*Brandon Carrell, M.D., Dallas, Texas.*

ARTHRODESIS OF THE OSTEO-ARTHRITIC HIP. R. Watson Jones. *Journal of the American Medical Association*, CX, 278, Jan. 22, 1938.

The factors causing incapacity during late osteo-arthritis of the hip joint are pain on movement and weight-bearing, and stiffness of the affected joint. Since pain is the dominating complaint, its relief should be given primary consideration.

An arthroplasty may be relied upon to increase the range of motion, but it does not ensure a painless joint. The author believes that in unilateral osteo-arthritis of the hip joint arthrodesis should be the treatment of choice. This procedure has fallen into relative disfavor since bone fusion has taken place only in bout 50 per cent. of the cases, and many are convinced that such a fusion produces or aggravates low-back pain. However, the fact is pointed out that arthrodesis causes a minimum incapacity and even relieves previously existing back pain.

A plaster spica is inadequate for complete fixation, but the rotatory movements may be completely checked by a three-flange nail driven from the femur into the bony pelvis. The nail is started below the greater trochanter and is directed through the femoral neck and head into the roof of the acetabulum. A plaster spica is applied, and the patient is kept recumbent for about three months. The entire procedure is now performed in two stages, an intra-articular fusion is done, followed from ten to fourteen days later by nailing and the application of a plaster spica.

Excellent results are reported in thirty-five cases. The back pain and muscle spasm, as a rule, disappear and from 30 to 40 degrees of pelvic motion develops, which is adequate for ordinary activities.

In thirteen cases in which the ages of the patients ranged from sixty to seventy-five, the author has done a subcutaneous nailing without the preliminary intra-articular fusion. A heavier nail is used, and the patient is up and walking in two weeks. Final end results in these cases have not been determined.—*Harold M. Childress, M.D., Dallas, Texas.*

VERTEBRAL CHORDOMA. S. Y. Minkin. *Khirurgiya*, I, 104, 1937.

A detailed review of the literature is presented, and a case of a vertebral chordoma arising from the transverse process of the eighth and ninth thoracic vertebrae is described. The diagnosis was established after surgical removal of the tumor. The treatment recommended in view of its malignant character is surgical in operable cases. The author's patient survived four years.—*Emanuel Kaplan, M.D., New York, N. Y.*

RESTORATION OF MOBILITY OF THE ELBOW JOINT AFTER THE METHOD OF MOUCHET. S. A. Flerov. *Khirurgiya*, III, 92, 1937.

The author believes that in the operative restoration of motion of the elbow joint

it is not important to interpose any fascia or soft tissue between the newly created joint surfaces; it is also not important to imitate the normal joint configuration.

The essential steps consist in resecting horizontally the joint surfaces, leaving a distance of about four to four and five-tenths centimeters between them. The lateral stability remains good in patients with normal muscles around the elbow joint. Of twelve patients operated upon by this method, the results were excellent in eight; two could not be traced; and two complained of pain and restriction of motion.—*Emanuel Kaplan, M.D., New York, N. Y.*

ON SUTURE TECHNIQUE OF FRACTURES OF THE OLECRANON. A NEW METHOD OF OPERATIVE TREATMENT. G. Y. Epstein. *Khirurgiya*, III, 103, 1937.

Several methods of suturing the fractured olecranon are described. The author gives a description of his own procedure, which essentially consists in passing the tendon of the palmaris longus through transverse drill holes in the fractured fragment and in the ulna. Several cases are reported with satisfactory results. The author also used this tendon for suture in a case of fracture of the patella.—*Emanuel Kaplan, M.D., New York, N. Y.*

BEHANDLUNG UND SPÄTRESULTATE BEI SCHWEREN BRÜCHEN DES HUMERUSGELENKFORTSATZES ERWACHSENER (The Treatment and End Results of Severe Condylar Fractures of the Humerus in Adults). Kurt Johannssen. *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, XLIV, 65, 1937.

The author reviews a series of twenty-two cases, of which fifteen were treated by conservative methods and the remainder by operation. He found that this fracture did not necessarily occur in the aged, nor was the left arm more affected than the right. In eleven of these patients good functional results were obtained, although there remained about 20 to 30 degrees of flexion and extension limitation and a very slight rotation limitation. Eleven other patients could not carry on their previous occupations, due to pain, in spite of the fact that there was no limitation of motion. There were poor results in three cases because of infection, or periosteal callus formation, or radial palsy. Pseudarthrosis and delayed union also played a part.

The author states that each case presents its individual complications and problems and so no set rule can be followed in the treatment. The object is to restore good anatomical position, and, where this cannot be done by manipulation, surgery is indicated. Good anatomical reposition does not necessarily mean good function.

This author claims that conservative treatment is far more advantageous than surgery. He treats most of the cases by means of splints, extension apparatus, wires through the condyles, and casts.—*L. A. Shure, M.D., Iowa City, Iowa.*

ÜBER DORNFORTSATZABRISSE (Fractures of the Spinous Processes of the Cervical Vertebrae). René Sommer. *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, XLIV, 84, 1937.

A review of three cases of fracture of the spinous processes of the cervical vertebrae gave the following information:

Case 1. Injury obtained through shoveling coal resulted in a simple fracture of the spinous process. The fragment was removed without any difficulty. Following the operation the patient would not return to work for many months because of a neurosis which followed his belief that the injury and operation were of a serious nature.

Case 2. The patient had radiating symptoms down the arms and legs. The fragment was removed and soon after this the patient developed more or less paralysis which was not due to but must have accompanied the original injury. However, he thought it was the result of the operation.

Case 3. In this case the patient had sustained fractures of the spinous processes of the fifth and sixth cervical vertebrae, associated with unconsciousness. This was treated

conservatively for three weeks and then the patient was allowed to be ambulatory. Eight months later the patient returned and presented typical cervical deformity. Roentgenograms disclosed that this was due to a compression fracture of the seventh cervical vertebra and a forward dislocation of the sixth cervical vertebra. These had been overlooked originally.

The author concludes that conservative treatment is more desirable. He also warns against missing any associated and more severe damage.—*L. A. Shure, M.D., Iowa City, Iowa.*

THE TREATMENT OF SEPTIC COMPOUND FRACTURES OF THE TIBIA WITH MAGGOTS. Stephen Maddock and Dorothy Jensen. *The New England Journal of Medicine*, CCXVII, 123, 1937.

During the past seven years the authors have treated forty-four cases of compound fracture of the tibia with infection of various degrees. Most of these were true compound fractures, but ten were compounded at operation. A number of compound fractures of other bones were treated, but, as tibial fractures predominated and gave neither the best nor the worst results, they were chosen for the report.

The technique used was that of débridement and application of maggots. The average hospitalization period was seventy days, the average number of days during which maggots were applied was 113, and the average time of healing was 269 days. Of the forty-four patients treated, thirty-two have healed lesions, four are under treatment, one was lost track of, two died of septicaemia, and amputations were performed in five.

The author is of the opinion that the maggot treatment offers the following advantages:

1. Rapid and complete débridement.
2. Discovery of hidden sequestra.
3. Opening of small pus pockets.
4. Stimulation of healthy granulation tissue.
5. Shortening of hospitalization.
6. Early rehabilitation.

The disadvantages of the treatment are:

1. Expense.
2. Discomfort to the patient.

C. W. Ruhlin, M.D., Iowa City, Iowa.

HYPERTROPHIC ARTHRITIS OF THE SPINE. John G. Kuhns. *The New England Journal of Medicine*, CCXVII, 317, 1937.

This discussion of hypertrophic arthritis of the spine gives the clinical course and the roentgenographic findings, with many theories as to cause and treatment. The causes suggested are trauma, glandular dysfunction, infection, and toxaemia. Radiating pain due to gradual closure of the neural foramina, which may lead to an error in diagnosis, is also discussed.

The treatment recommended is complete rest in a plaster shell or upon a firm bed, and physiotherapy. Manipulation is discouraged, as it produces an increase in symptoms. Diet and glandular therapy are also considered, but the author feels that they are of doubtful value.—*C. W. Ruhlin, M.D., Iowa City, Iowa.*

SUPRACLAVICULAR BRACHIAL PLEXUS BLOCKS: AN ACCESSORY THERAPEUTIC MEASURE IN ARTHRITIS OF THE SHOULDER JOINT AND ALLIED CONDITIONS. James M. Tarsy and Otto Steinbrocker. *New York State Journal of Medicine*, XXXVII, 1275, 1937.

The authors have utilized the supraclavicular brachial-plexus block as an accessory therapeutic measure in arthritis and allied conditions of the shoulder joint. The patients

used as controls were good risks and free from procaine sensitivity, in whom the common therapeutic measures had failed to give relief. Twenty-one patients with arthritis, bursitis, and brachial-plexus neuralgia were treated. The anatomical relations were carefully taken into consideration, and the point of injection was lateral to the subclavian artery, posterior to the clavicle, and anterior to the first rib. From five to ten cubic centimeters of 1-per-cent. procaine was injected in each case. Seventeen of the twenty-one patients showed moderate to excellent recovery of function.

The return of function is interestingly accounted for on the basis that muscle spasm, previously caused by a reflex action, has been released. The lasting effect of the procaine is explained rather conclusively as producing a block, thereby prolonging the sensory cycle long beyond the effect of the anaesthetic. It is also thought that the pain threshold has been elevated and that the previous stimulus no longer produces pain and, therefore, allows freedom of motion.—*C. W. Ruhlin, M.D., Iowa City, Iowa.*

Simple Apparatus for Re-education of Paralysed Muscles. Campbell McKenzie. *New Zealand Medical Journal*, No. 196, 380, 1937.

The author describes an apparatus for developing voluntary motion in paralyzed limbs, which was devised by Mr. V. Pike, the masseur at Timaru Hospital. The apparatus consists of a piece of aluminum, one-eighth of an inch in thickness, in the shape of a protractor. It has a movable arm pivoted around a thrust bearing, which swings on a ball-bearing roller. A track of monel metal is screwed to the aluminum to prevent the roller from cutting into it. Inside the arm is a sliding extension piece to which is attached a foot support.

The use of this apparatus is advocated for the following reasons:

1. It is simple and compact, and, as it does away with the effect of gravity, it is better than the bath.
2. It almost entirely abolishes friction.
3. The limb is under better control than it is with the bath, slings, or a plane surface.
4. Exercise can be graded, resistance added, and amplitude measured with great ease.
5. It catches and holds the patient's attention.—*H. Walden Fitzgerald, F.R.A.C.S., Dunedin, New Zealand.*

Auckland Clinical Society Reports. *New Zealand Medical Journal*, No. 197, 43, Feb. 1938.

The case described by Mr. Morris Axford was that of a simple transverse fracture of the patella, which had been treated by complete excision of the bone and repair of the quadriceps muscle with fascial strips. The patient, a man of sixty-seven years, five weeks after the accident walked without any perceptible limp, with a powerful extension of the knee, no wasting of the quadriceps, and 60 degrees of active flexion of the knee. He was able to do light work.—*H. Walden Fitzgerald, F.R.A.C.S., Dunedin, New Zealand.*

Fracture of Neck of Scapula. Max R. Charlton. *Northwest Medicine*, XXXVII, 18, Jan. 1938.

The author refers to the scarcity of reported cases of fracture of the neck of the scapula and presents a bilateral case of his own. The fractures in this case were caused by a falling tree which struck the patient across the back. Usually the fragment is displaced downward and inward; this occurred in this case on the right side, but the left side was not displaced.

Diagnosis is made by abduction of the arm and inward pressure on the shoulder, causing pain, and by the presence of marked swelling over the entire scapula.

A variety of methods for reduction are described, but the author believes that ab-

duction of the arm, with traction, is the best. He advises against too much effort, if reduction cannot be accomplished readily.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

LESIONS OF THE CRUCIATE LIGAMENTS OF THE KNEE. RESULT OF THE RECONSTRUCTION OF THE ANTERIOR CRUCIATE AND OF THE TIBIAL COLLATERAL LIGAMENTS. G. Scoppetta. *Ortopedia e Traumatologia dell'Apparato Motore,* May-June, 1937.

In this article the author discusses the question as to whether the two cruciate ligaments are ever in a state of equal tension. From experimental studies he thinks that they are not, which perhaps explains why lesions of the anterior cruciate ligament are so much more frequent. This ligament gets into action first, and the posterior cruciate ligament has more support from the posterior capsule. Stretching of the cruciate ligament without rupture is mentioned as a cause of disturbed ligamentous function. Reaccumulation of bloody fluid in the joint after tapping points to rupture; fat drops suggest avulsion of the tibial spine. The author reports the results which he obtained in two cases of repair of the cruciate ligaments.—*A. W. Ciani, M.D., Iowa City, Iowa.*

RECONSTRUCTION OF THE ACETABULAR ROOF (SHELVING) AS JUDGED BY A STUDY OF FOURTEEN CASES. Luigi Bocchi. *Ortopedia e Traumatologia dell'Apparato Motore,* May-June, 1937.

The author regards this "shelving" operation as logical, generally applicable, and simple, yielding satisfactory results if one is satisfied to use it as an aid, not as a cure, for it is rare that a complete functional or anatomical cure follows its use. Functional reeducation is an important accompaniment. The best results are obtained in the youngest patients. In patients over twenty years of age other methods are superior. Pain is the symptom most often relieved; the limp is only in part obviated. It is important not to place the shelf too low, in which case it is more readily absorbed.—*A. W. Ciani, M.D., Iowa City, Iowa.*

L'ANTIPYRINE DANS LE TRAITEMENT DU RHUMATISME ARTICULAIRE AIGU (Antipyrine in Treatment of Acute Articular Rheumatism). L. Bouchut et M. Levrat. *La Presse Médicale,* XLV, 1467, 1937.

Following the discovery of antipyrine, this drug was used extensively in the treatment of acute rheumatic fever. With the introduction of the salicylates, antipyrine has fallen into an unjustifiable disuse. The authors claim that the accidents attributed to the use of antipyrine are due, not to intoxication, but to intolerance. In their experience, harmful effects have not been observed. Indeed, they note that where albuminuria is caused by a rheumatic affection of the kidneys, the albuminuria is definitely benefited. Next to the salicylates, antipyrine is considered specific, as well as antipyretic and analgesic, in its effect upon the rheumatic process. In cases where the condition is resistant to the action of the salicylates, or where intolerance limits the use of the salicylates, antipyrine may be given confidently. Doses as large as six to eight grams have been given daily for several days and the action has been continued with daily doses of four grams for longer periods of time. The drug is given by mouth in capsules or in solution. Because of certain irregularities in the commercial product, the authors recommend special preparations of the drug.—*Henry Milch, M.D., New York, N. Y.*

INDICATIONS OPÉRATOIRES ET TECHNIQUE DE L'INTERVENTION DANS LES FRACTURES DES APOPHYSES TRANSVERSES LOMBAIRES (Operative Indications and Technique in Fractures of the Transverse Lumbar Processes). R. Dupont et H. Evrad. *La Presse Médicale,* XLV, 1573, 1937.

The disability resulting from fractures of the transverse processes of the lumbar vertebrae, treated conservatively, varies from an estimate of 85 per cent. to 10 per cent. The results of the operative treatment "are always excellent". Operative intervention is not recommended until after conservative treatment by means of a plaster jacket has been tried for at least two or three months. If, at the end of that time, symptoms still persist, operation is advised.

With the patient in the ventral position, the operative approach is made through a long, curved, skin incision, so placed as to be external to the aponeurotic incision. This is made directly over the prominence of the erector spinae muscles, between the spinous processes and the lateral groove which marks approximately the tips of the transverse processes. The muscle fibers are separated, and the transverse process is removed subperiosteally. The base of the transverse process is removed by rongeur. The wound is closed by interrupted muscle stitches. At the end of about two weeks, gradual resumption of function is permitted.—*Henry Milch, M.D., New York, N. Y.*

Blood Vessel Markings in the Dorsal Vertebrae Simulating Fracture. Kenneth S. Davis. *Radiology*, XXIX, 695, 1937.

Transverse slits in the bodies of thoracic vertebrae were observed in about 10 per cent. of all lateral roentgenograms of the thoracic spine, in persons from twenty to seventy-six years of age. These slits apparently divide the bodies into symmetrical halves.

Lateral roentgenograms of spines removed from cadavera showed these transverse markings in approximately 22 per cent. Injection of the blood vessels of the removed vertebrae with a barium suspension and x-raying them, followed by sectioning in transverse, anteroposterior, and longitudinal planes, showed the transverse linear marks to be due to blood-vessel channels in practically all cases. The vessels come from the anterior spinal arteries, but always enter the vertebral bodies in the center of the posterior body wall, just above the exit of the basivertebral veins.

The "translucent split" seen in the anterior portion of the bodies of vertebrae in children is probably due to a middle zone of ossification of less density than the zones between which it lies. This slit extends from before backward, and does not persist in adults.

Recognition of these anomalies is important in cases involving the question of trauma to the spine, with possibility of fracture.—*Edward N. Reed, M.D., Santa Monica, California.*

Giant-Cell Tumors of the Spine. G. E. Richards and A. C. Singleton. *Radiology*, XXX, 43, Jan. 1938.

Benign giant-cell tumor occurs about half as frequently as primary malignant bone tumors. The usual age incidence is from fifteen to forty years. The most common sites are the upper tibia, the lower femur, the lower radius, the epiphyses of other long bones, the jaw, and the spine. This tumor practically always involves the epiphysis, and it is central in origin, expansive in type, and often asymmetrical. Cortical destruction and periosteal expansion with subperiosteal new bone formation produce a "blown-out" appearance. There is a sharp demarcation between tumor and normal bone. Coarse bony trabeculation gives it a characteristic loculated appearance. Another group, less numerous, are frankly osteolytic, with no attempt at bone repair, no trabeculation, and without sharp demarcation between tumor and normal bone, the cortex usually being completely absorbed. Tumors of this type are difficult to differentiate from primary malignant new growths or from metastases. Giant-cell tumors usually do not cross cartilage. Pathological fracture is common. The disease is relatively uncommon in the vertebrae. While any part of a vertebra may be involved, there is a predilection for pedicles and transverse processes. The diagnosis is difficult because of the multiplicity of bone lesions which affect the spine.

Two cases of benign and one case of malignant giant-cell tumor involving the spine are reported in detail. Treatment by radiation was effective in causing regression, but marked bone absorption and apparent extension frequently occur shortly after institution of radiation therapy, to be followed later by bone regeneration.

Since tumors having all the clinical and roentgenological characteristics of benign giant-cell tumor occasionally are malignant, the authors feel that aspiration biopsy is advisable in other locations than the spine. There it is of much less value, since conservative treatment must be used regardless of the type of tumor.

Curettage, followed by a cauterization of the cavity with an escorotic, is followed by recurrence in from 14 to 20 per cent. of the cases.

Treatment by radiation, although slow in effect and frequently producing a stage of lysis and apparent extension before bone regeneration begins, is gaining ground.—*Edward N. Reed, M.D., Santa Monica, California.*

PENETRATING WOUNDS OF THE KNEE. I. THE PRODUCTION OF EXPERIMENTAL ARTHRITIS. II. THE ESCAPE OF PARTICULATE AND FLUID MATERIAL FROM THE NORMAL KNEE JOINT. A. Lewer Allen. *The South African Journal of Medical Sciences*, I, 31, 1935.

Penetrating wounds of the knee caused by sharp splinters of rock are injuries frequently encountered among the workers in gold mines on the Witwatersrand. In some of these injuries an acute arthritis occurs, the organism being almost invariably a hemolytic streptococcus.

Experimental reproduction of these conditions was attempted by injecting organisms into the knee joints of cats. An acute arthritis was produced. The organisms escaped from the joints at an early stage and were sometimes found in the lymph nodes draining the joints. Particulate matter (India-ink particles and blood corpuscles) and non-particulate solutions (1-per-cent. trypan blue) leave the joint of the cat by way of the lymphatics and reach the iliac glands. Movement of the joint acts as a pump ("lymph-heart" action), being mainly responsible for the escape of fluid by way of the lymphatics.—*Clark W. Heath, M.D., Boston, Massachusetts.*

HERNIATION OR RUPTURE OF THE INTERVERTEBRAL DISC. A REPORT OF TWO CASES. R. F. Slaughter. *Southern Medical Journal*, XXX, 803, 1937.

The author presents two cases which were proved at operation, and the patients were completely relieved of disability that had been designated as permanent. Trauma was present in both cases. The patients complained of low backache with sciatica-like pain. There was increased protein in the spinal fluid, but no block. Roentgenographic studies after injection of iodized oil in one case showed a filling defect.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR WITH THE SMITH-PETERSEN NAIL. James W. Davis. *Southern Medicine and Surgery*, C, 45, Feb. 1938.

Fractures of the intracapsular neck of the femur constitute one of the most distressing problems of today, but this problem is most accurately handled by the subcutaneous fixation of the fracture, after reduction, with a Smith-Petersen nail. The author uses fluoroscopic guidance in inserting a guide wire or pin and then drives the nail on over the pin. He has also used the Austin Moore metal bone pins with good results.

The author believes that in his cases the mortality and morbidity rates have considerably decreased since he has used this method of fixation of femoral-neck fractures.—*Herbert E. Hipps, M.D., Marlin, Texas.*

DIE BEHANDLUNG DER FOLGEZUSTÄNDE NACH KINDERLÄHMUNG (The Treatment of the Conditions Following Infantile Paralysis). Julius Hass. *Wiener klinische Wochenschrift*, L, 1670, 1937.

A general discussion of the orthopaedic management of the subacute and chronic stages of poliomyelitis contains numerous statements of interest to orthopaedic surgeons. General measures for the prevention of deformity are of the greatest importance. If this fact has been overlooked, contractures are most gently corrected by the "*Quengel*" method of Mommsen. Muscles are strengthened by baths, massage, electrical stimulation, gymnastics. The patient should be started walking as soon as possible, for walking is the best exercise. Various types of apparatus may be necessary to permit this. There is still hope of improved function two to three years after the acute attack, largely through hypertrophy or substitution of muscles. Operations, including tendon transplantation, arthrodesis, and arthroereisis, are discussed.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

DER ANGEBORENE KLUMPFUSS (Congenital Club-Foot). Georg Hohmann. *Zeitschrift für ärztliche Fortbildung*, XXXIV, 609, 1937.

A brief summary of the treatment of congenital club-foot in rather popular style emphasizes the importance of early gentle correction of the adduction, followed by correction of the supination of the forefoot and later of the hindfoot, and, finally, correction of the equinus. One should guard against producing a flat foot or rocker foot. Various operative measures are mentioned.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

FAMILIÄRES VORKOMMEN DER PROTRUSIO ACETABULI. BEITRAG ZUR ÄTIOLOGIE. [Familial Incidence of Protrusion of the Acetabulum. Contribution to Etiology.] Gickler. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 14, 1937.

The author observed two cases of Otto's protrusion of the acetabulum in one family. Both patients were adults, and in each case the lesion was of long duration. He believes the lesion is congenital, in that a weak acetabular floor gives way. He also reports two cases in non-related children. In one a slipped epiphysis of the femur was present. On this rather slim evidence he decides that the lesion is familial.—*J. E. Milgram, M.D., New York, N. Y.*

DIE BEDEUTUNG DES CHOPART'SCHEN GELENKES FÜR DIE DORSAL- UND PLANTARFLEXION BEI VERSTEIFUNGEN DES OBEREN SPRUNGGELENKES (Significance of Chopart's Joint for Dorsiflexion and Plantar Flexion in Ankylosis of the Ankle Joint). Max Zimmermann. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 20, 1937.

Measurement of five cases of ankle-joint ankylosis demonstrated dorsiflexion ranges up to an angle of 90 degrees and plantar-flexion ranges to an angle of 125 degrees.

Despite the common teaching that normally 20 degrees of motion in the plantar and dorsal direction is present in Chopart's joint, the author tested some children and adults by attempted plaster immobilization of the hind foot. He reports that children show from 10 to 15 degrees of such motion and adults but 5 degrees.

The increased ranges in feet which have been operated upon are a compensatory development.—*J. E. Milgram, M.D., New York, N. Y.*

ERBBIOLOGISCHE UNTERSUCHUNGEN ÜBER DIE ANLAGE ZUR "ANGEBORENEN" HÜFTVERRENKUNG (Hereditary Biological Investigation in Congenital Dislocation of the Hip). Alexander Faber. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 140, 1937.

The author repeats the very important dictum that if the hips of families are roentgenographically examined, three cases of dysplasia of the hip will be found for one case of true congenital dislocation. In other words, the lesion is four times as frequent biologically as one might think.—*J. E. Milgram, M.D., New York, N. Y.*

DIE BIFURKATION MIT HILFE DES TROCHANTER MINOR (The Bifurcation Operation with the Help of the Lesser Trochanter). Julius Hass. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 353, 1937.

In neglected cases of dislocation of the hip in which the lesser trochanter lies opposite the acetabulum, this trochanter forms an excellent weight-bearing point in subtrochanteric osteotomy. Hass recommends adduction of the proximal fragment with the end of the diaphysis under it instead of in the acetabulum as in the classic bifurcation operation. With this change, he obtains better motion and prolonged weight-bearing with less pain.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ZWEI FÄLLE VON OS NAVICULARE PEDIS BIPARTUM (Two Cases of Os Naviculare Pedis Bipartitum). Cornelius Volk. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 396, 1937.

The author reports two cases of bipartite navicular. Each case was unilateral and in an adult in the third decade of life. Each patient complained of foot pain. One was treated, and relieved with an insole. Ossification of the navicular begins at the age of from three to five, and, in part of the cases reported, originates in two centers of ossification.

The shape of the astragalus in these two cases was somewhat unusual, the head of the bone having a changed contour to articulate with the abnormal navicular.—*J. E. Milgram, M.D., New York, N. Y.*

ZUR BEHANDLUNG DES PLATTFUSSES NACH DER OPERATIONSMETHODE VON PROF. DR. PETŘIVALSKÝ (The Treatment of Flat-Foot by the Petřivalský Operation). Čestomir Vohnout. *Zentralblatt für Chirurgie*, LXIV, 310, 1937.

Moderately severe cases of flat-foot which do not improve under conservative measures are treated by an operation which raises the inner longitudinal arch and corrects the pronation of the hindfoot. This is accomplished by making a long rectangular periosteal flap on the medial aspect of the lower portion of the tibia. The flap remains attached just above the internal malleolus. The periosteal flap is turned down and fastened to the scaphoid and cuneiform bones and along the internal ligaments of the foot.

This operation has been performed by the author seven times with good results in all but one case. Petřivalský has been performing this operation since 1930. A similar operation was described by Löffler in 1931.—*Harold Unger, M.D., Iowa City, Iowa.*

ÜBERBRÜCKUNGPLASTIK BEIM MUSKULÄREN SCHIEFHALS BEHUFS HERSTELLUNG EINES NORMALEN HALSRELIEFES (Bridge Plastic Operation in Muscular Wry Neck to Restore Normal Neck Contour). C. Springer. *Zentralblatt für Chirurgie*, LXIV, 1634, 1937.

In place of subcutaneous or open tenotomy, the author advocates division of the contracted muscle with bridging of the gap so created in the sternocleidomastoid. To bridge the gap, he utilizes a strip of fascia lata. By this means, the contour of the neck is better maintained. The method is applicable to secondary operations to restore neck contour. A double-tailed flap might conceivably be employed and attached both to the sternal and to the clavicular stumps. The author advises support of the neck for one year. He believes that this procedure should not be employed in patients under the age of two years.—*J. E. Milgram, M.D., New York, N. Y.*

DIE ENTWICKLUNG DER JUVENILEN KYPHOSE (The Development of Kyphosis Juvenilis). Johannes Schildbach. *Zentralblatt für Chirurgie*, LXIV, 2086, 1937.

The author reports 167 cases from the Orthopaedic Department of the University Hospital. From his study of these cases he has noted the following typical changes:

(1) a slightly rounded kyphos between the seventh and tenth thoracic vertebrae with prominence of the ribs; (2) narrowing of the vertebral bodies anteriorly with irregularity of the epiphyses. The roentgenographic examination shows four stages,—namely, irritation, destruction, reparation, and proliferation. The early symptoms, as shown in the roentgenogram, are narrowing of the intervertebral space and disturbances of the epiphysis (*Randleiste*). If the process is progressive, wedge-shaped vertebrae with resulting spondylosis may develop. In some cases bony nodules were observed. The treatment consists of orthopaedic exercises, correction by recumbency on a frame, complete rest in fresh air for several months, and continued observation for several years.—*Ernst Bettmann, M.D., New York, N. Y.*

DIE OPERATIVE VERLÄNGERUNG DES BEINES (Operative Lengthening of the Leg). J. Schulz. *Zentralblatt für Chirurgie*, LXIV, 2294, 1937.

This operation involves two procedures,—namely, the section of the bone and the stretching of the tissue. The author describes the old subtrochanteric oblique osteotomy by which lengthening of six centimeters was possible, especially in cases of adduction contracture of the hip. The transperiosteal method has been abandoned because periosteal necrosis and pseudarthrosis have been observed. Osteotomy between the middle and inferior thirds of the femur is recommended because the periosteum remains in contact with the musculature. The author advises gradual extension, beginning with three kilograms and increasing to twenty kilograms. Weight-bearing is not permitted before the fifth month.—*Ernst Bettmann, M.D., New York, N. Y.*

GRUNDSÄTZLICHE BEMERKUNGEN ZUR ANZEIGESTELLUNG UND ZUR BEHANDLUNG VERSCHLEPPTER BZW. PSEUDARTHROTISCH ODER NEARTHROTISCH GEHEILTER MEDIALER SCHENKELHALSBRÜCHE (Axiomatic Observations on the Symptoms and Treatment of Pseudarthrosis or Non-Union of the Neck of the Femur). Fritz Felsenreich. *Zentralblatt für Chirurgie*, LXIV, 2407, 1937.

The nail treatment of Smith-Petersen, Johansson, and Böhler is compared with the subtrochanteric wedge osteotomy of Pauwels. The first method permits earlier bony consolidation and weight-bearing. The most important part of the treatment is the reduction of the fracture, followed by extension for two weeks or until the neck is in position opposite the head. Bony union is obtained by longitudinal traction in abduction and inward rotation. Before manipulation three roentgenograms should be taken in the following positions: inward rotation, outward rotation, and lateral. Abduction of at least 25 degrees should be maintained. If there is much resorption from the head and neck, osteotomy is preferred, after which the legs are kept in abduction for fourteen weeks and no weight-bearing is allowed.—*Ernst Bettmann, M.D., New York, N. Y.*